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New species of Fungi

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Lepiota brunnescens

Pileus thin, convex or nearly plane, obtuse or umbonate, whitish, the cuticle soon cracking and forming brownish granules or squamules except in the center, sometimes radiately rimose on the margin, flesh white, taste sweet; lamellae close, ventricose, free, white; stem equal or slightly thickened toward the base, hollow, fibrous, white, with a slight but subpersistent annulus near the middle; spores elliptic, 6–8 μ long, 4–5 μ broad.

Pileus 2–3 cm. broad; stems 3–5 cm. long, 2–4 mm. thick.

Open woods and grassy places, near St. Louis, Mo. July and August. N. M. Glatfelter.

This singular species, when fresh, resembles *Lepiota cristata*, but in drying, the whole plant changes color. The stem below the annulus at first becomes reddish brown, but soon changes to brown and in 12–24 hours the whole plant becomes brown. Bruises also cause a change of color.

Lepiota Glatfelteri

Pileus thin, convex or nearly plane, obtuse or slightly umbonate, slightly and innately fibrillose, gray, grayish brown or brown, sometimes tinged with purple, the center usually darker, sometimes radiately rimose on the margin, flesh white; lamellae close, lanceolate, free, white or whitish; stem equal or nearly so, firm, stuffed or hollow, white, the annulus slight, persistent; spores broadly elliptic, 6–8 μ long, 4–5 μ broad.

Pileus 2.5–5 cm. broad; stem 4–5 cm. long, 2–4 mm. thick.

Ground in woods, near St. Louis. July, August. N. M. Glatfelter.

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A rare but peculiar species belonging to the section Clypeolaria, but distinct and easily recognized by the dark but somewhat variable color of the pileus, of which the cuticle does not form scales but sometimes becomes radiately rimose on the margin.

Tricholoma viscosum

Pileus fleshy, convex, the irregular or wavy margin often turned upward when old, even, glutinous, shining when dry, yellowish tawny, darker or reddish brown in the center, flesh white, odor slight but unpleasant; lamellae narrow, close, nearly free, white; stem firm, equal, brittle, solid, flexuous, glutinous, white above, brown below; spores minute, subglobose, 3–4 μ long.

Pileus 2–5 cm. broad; stem 2.5–4 cm. long, 4–5 cm. thick.

Low ground near St. Louis. August and September. N. M. Glatfelter.

Clitocybe piceina

Pileus fleshy, firm, convex or nearly plane, dry, white or whitish, tinged with gray when young, flesh compact, white, taste pungent, odor strong, disagreeable; lamellae close, decurrent or sometimes strongly decurrent in lines running down on the stem, creamy white; stem equal or nearly so, firm, stout, solid, subfibrous, commonly striate at the top with raised longitudinal lines; spores globose, 5–6 μ in diameter.

Pileus 6–10 cm. broad; stem 5–7 cm. long, 12–18 mm. thick.

Under spruce trees near Chicago. September. W. S. Moffat and L. H. Watson.

In the dried specimens the pileus sometimes assumes a yellowish tint. The species is closely allied to *C. cerussata* and *C. albissima*. From the former it may be separated by its larger globose spores and from the latter by its whitish color being less clear and persistent. From both it differs in the more strongly decurrent lamellae, pungent taste and disagreeable odor.

Collybia umbonata

Pileus thin, conic becoming convex or nearly plane with deflexed margin, prominently umbonate, glabrous, bay red or chestnut color, sometimes darker in the center than on the margin; lamellae numerous, subdistant, narrowed toward the stem, nearly free, whitish; stem rather long, glabrous, equal or slightly tapering upward, hollow, radicating, colored like or a little paler than the pileus; spores minute, elliptic, 6–8 μ long, 4–5 μ broad.

Pileus 2–3 cm broad; stem 5–15 cm. long, 4–6 mm. thick.

On and about old redwood stumps. California. December. W. R. Dudley and E. B. Copeland. The color of this species is similar to that of some forms of *C. dryophila*, but in structure it is more closely related to *C. radicata*. The underground part of the stem is sometimes as long as the part above ground.

Russula luteobasis

Pileus convex, becoming nearly plane, even or slightly and indistinctly striate on the margin, rosy red or pink, becoming paler or yellowish either wholly or in the center only, the cuticle separable, flesh white or whitish ; lamellae adnate or adnexed, equal, creamy yellow or whitish, becoming dingy with age or in drying ; stem nearly equal, slightly furfuraceous, stuffed, white, yellow at the base ; spores subglobose, 8 μ long, sometimes only 7 μ broad.

Pileus 2.5–7 cm. broad ; stem 2.5–5 cm. long, 4–12 mm. thick.

Near St. Louis, Mo. June to August. N. M. Glatfelter. A species well marked by the change of color in the pileus and the yellow base of the stem.

Clitopilus sphaerosporus

Pileus fleshy but thin, nearly plane, with the margin involute or decurved, umbonate or slightly depressed in the center, dry, minutely tomentose pubescent, dark gray or blackish-brown, flesh white ; lamellae thin, narrow, close, unequal, slightly decurrent, whitish, faintly tinged with pink ; stem equal or slightly tapering upward, solid, firm, colored like the pileus, with a white mycelioid tomentum at the base ; spores pale pink, globose, uninucleate, 5–6 μ in diameter.

Pileus 1–2.5 cm. broad ; stem 2–4 cm. long, 2–4 mm. thick.

Among fallen leaves in ravines. Near St. Louis, Mo. August and September. Rare. N. M. Glatfelter. The pink tint of the lamellae and spores is so faint that by careless observation the fungus is liable to be mistaken for a clitocybe.

Flammula eccentrica

Pileus thin, broadly convex, obtuse or slightly umbilicate, dry, minutely squamulose, tawny, yellowish or reddish ferruginous, flesh whitish ; lamellae rather broad, close, somewhat sinuate adnate, dingy, ochraceous, becoming ferruginous : stem equal or slightly tapering upward, commonly eccentric, solid, fibrillose, yellowish or dingy ochraceous, becoming brownish without and within ; spores bright ferruginous, elliptic, 15–16 μ long, about 8 μ broad.

Pileus 2.5–3.5 cm. broad; stem 2–3 cm. long, 4–8 mm. thick, often curved.

Decaying wood. Near St. Louis, Mo. September and October. N. M. Glatfelter.

Flammula Braendlei

Pileus convex becoming nearly plane with incurved margin, sometimes irregular, fibrillose squamulose, especially in the center, slightly viscid, purplish when young, soon yellowish or yellowish white, sometimes with bluish green stains, flesh whitish; lamellae thin, close, adnate or slightly decurrent, bright ferruginous when mature; stem equal or slightly tapering upward, fibrillose, hollow, whitish streaked with brown, veil webby, sometimes forming a silky zone on the stem and becoming conspicuous by the spores lodging on it; spores elliptic, 6–8 μ long, 4–5 μ broad.

Pileus 2.5–5 cm. broad; stem 2.5–5 cm. long, 4–8 mm. thick.

Single or cespitose on decaying trunks. September to November. Near Washington. F. J. Braendle. Near St. Louis N. M. Glatfelter.

This species is quite attractive by reason of the bright ferruginous color of the mature lamellae and the spores. It belongs to the section *Sericellae*. Sometimes the pileus is slightly umbilicate.

Agaricus solidipes

Pileus fleshy, firm, convex, squamose or rimose squamose, white or whitish, involute on the margin, flesh white, unchangeable, taste sweet, agreeable; lamellae close, free, dull pink changing to dull sepia, finally brownish black; stem very short, equal or tapering upward or downward, glabrous, solid, white or whitish, the white veil slight, often adhering entirely to the margin of the pileus; spores elliptic, 8–10 μ long, 5–6 μ broad.

Pileus 2–7 cm. broad; stem 2–4 cm. long, 6–10 mm. thick.

Prairie pastures. Colorado. June. E. B. Sterling.

A species well marked by its squamose pileus, involute or incurved, often appendiculate margin and by its short solid stem.

Agaricus rutilescens

Pileus fleshy, firm, convex with incurved margin, becoming nearly plane, even or sometimes rimose and minutely fibrillose, dingy white, becoming ferruginous, reddish-brown or bay in drying, flesh whitish changing to reddish where cut or broken; lamellae close, narrow, free, reddish becoming blackish-brown; stem equal or nearly so, firm, stuffed, silky, white, changing to reddish where

wounded, often abruptly bulbous at the base, veil white, often adhering partly to the margin of the pileus and partly to the stem ; spores broadly elliptic, 7–8 μ long, 5–6 μ broad.

Pileus 2.5–6 cm. broad ; stem 5–10 cm. long, 6–10 mm thick.

Manured ground in pasture. Denver, Colorado. June. E. B. Sterling.

This differs from *Agaricus compester rufescens* in having its pileus minutely fibrillose, in its flesh becoming reddish where wounded, not bright red, and in its gills being at first reddish instead of white. It resembles *Ag. maritimus* in some respects but differs in its assumed color and in the absence of a seaside odor.

Agaricus sphaerosporus

Pileus fleshy, firm, broadly convex, sometimes slightly depressed in the center, glabrous, whitish, the cuticle sometimes rimose, and the incurved young margin occasionally wavy or irregular when mature, flesh white, unchangeable ; lamellae thin, close, rounded behind, reaching the stem, but free from it, rosy red, becoming blackish-brown ; stem nearly equal, thick, firm, solid, straight or curved, whitish, the thin white veil rupturing and adhering partly to the margin of the pileus and partly to the stem, forming a slight, fringed soon evanescent annulus ; spores globose or nearly so, 7.5–8 μ long, 6–7.5 μ broad.

Pileus 7–12 cm. broad ; stem 3–10 cm. long, 2–3 cm. thick.

Rich soil. Denver, Colorado. June. E. B. Sterling. This species closely resembles large forms of the common mushroom, from which it may be separated by its glabrous pileus, solid stem and nearly globose spores. Mr. Sterling has eaten it freely without harm and considers it a good edible mushroom.

Agaricus cothurnatus

Pileus fleshy, convex with involute margin, dry, glabrous or minutely pulverulent on the margin, chalky white, flesh white ; lamellae close, free, chocolate color becoming black ; stem nearly equal, white, with dense radicular fibers at the base, sheathed below by the white veil which forms a cup-like annulus with lacerated margin above ; spores subglobose, 8–9 μ long, 7–8 μ broad.

Pileus 5–7.5 cm. broad ; stem 3–5 cm. long, 10–12 mm. thick.

Rich soil along roadsides and paths. Denver, Colorado. March. E. B. Sterling.

The chocolate color of the young gills and the sheathed base of the stem are notable distinguishing characters of this species.

Marasmius Copelandi

Pileus thin, tough, broadly convex, glabrous, tawny, taste and odor strong, unpleasant; lamellae few, unequal, distant, adnate, pallid; stem slender, tough, hollow, velvety pubescent and brown below, paler and less densely pubescent above; spores subfusiform, more sharply pointed at one end, 12–15 μ long, 4 μ broad.

Pileus 1–2 cm. broad; stem 4–6 cm. long, 1–2 mm. thick.

On dead leaves of *Quercus densiflora*. Woodside, California. December. E. B. Copeland.

It is related to *M. perforans*.

Clavaria myceliosa

Stem slender, solid, irregularly branched above, tawny, with an abundant mycelium which forms whitish, branching strands among decaying leaves and twigs; branches short, divergent or wide spreading with few branchlets, colored like the stem, the ultimate branchlets mostly acute, whitish; spores subglobose, 4 μ long. Scattered or gregarious, 1–2.5 cm. tall, stems about .5 mm. thick.

Among fallen leaves and twigs under redwood trees. Mountains near Stanford University, California. December. E. B. Copeland.

The abundant rhizomorphoid mycelium is a marked feature of this species. The plant is inodorous but has a slight peppery taste. It is allied to our eastern *C. pusilla*, but it is a smaller, more slender plant with the slender stem branched above only, and with the few short branches more widely spreading.

Helvella Stevensii

Pileus somewhat saddle-shaped, the two lobes deflexed, suborbicular, free, white, becoming yellowish or creamy yellow with age and brown in drying, under surface persistently white, even, pruinose velvety; stem terete, even, solid or stuffed, occasionally hollow in large specimens, pure white, pruinose velvety above; asci cylindric; spores even, broadly elliptic, 20 μ long, 12 μ broad, usually containing a single large nucleus; paraphyses filiform, clavate at the apex, colorless.

Plant 4–5 cm. tall; pileus 10–20 mm. broad.

Open woods of oak and hickory. Oakland co., Mich. June. R. H. Stevens.

Related to *H. gracilis* and *H. Panormitana*, but differing from both in the pure white color of the young fresh plant.

NEW YORK STATE MUSEUM.

Hepaticae of Puerto Rico

IV. ODONTOLEJEUNEA, CYCLOLEJEUNEA AND PRIONOLEJEUNEA

ALEXANDER W. EVANS

(WITH PLATES 8–12)

ODONTOLEJEUNEA

In his subgenus *Odonto-Lejeunea*, Spruce * grouped together a number of *Lejeuneae Holostipae* in which dentate or spinose leaves were borne on a prostrate axis, the latter being closely adherent to the substratum by means of radicelliferous discs develdope on the underleaves. In the other subgenera of this group, in which dentate or spinose leaves also occurred, as, for example, *Thysano-Lejeunea* and *Dicrano-Lejeunea*, the leafy axes were pendulous or ascending from a prostrate caudex and were almost or quite destitute of rhizoids. *Odonto-Lejeunea* was further characterized by a strongly flattened perianth more or less toothed along the sharp lateral keels and emarginate at the apex. Although classed among the *Holostipae*, Spruce included in his subgenus certain species, such as *Lejeunea Peruviana* Lehm. & Lindenb., in which the majority of the underleaves were bifid, and others, such as *L. convexistipa* Lehm. & Lindenb., in which a tendency toward the development of bifid underleaves might sometimes be observed. Schiffner's genus *Odontolejeunea* † has the same limits as Spruce's subgenus,but Stephani understands the genus in a somewhat more extended sense and includes in it at least one species, *L. accedens* Gottsche, ‡ which Spruce referred to *Priono-Lejeunea* (under the name *L. leptocardia* Spruce). In this species, as well as in certain others recently described by Stephani,§ the underleaves are invariably bifid. Although in many respects a natural group, the genus *Odontolejeunea* as understood by Stephani or even by Schiffner is more comprehensive than is usual among the

* Hep. Amaz. et And. 142. 1884.

† Engler & Prantl, Nat. Pflanzenfam. 1^3: 127. 1893.

‡ Hedwigia, 27: 284. 1888.

§ *L. c.* 35: 120. 1896.

Lejeuneae and includes an almost continuous series of species connecting the very different genera *Dicranolejeunea* and *Prionolejeunea*. In fact, such a species as *O. lunulata* (Web.) Schiffn., which may be considered the type of the genus, is much more closely related to certain *Dicranolejeuneae* than it is to *L. accedens* or even to *L. convexistipa;* and *L. accedens*, on the other hand, is hardly to be separated generically from such a *Prionolejeunea* as *P. microdonta* (Gottsche) Steph.

Fortunately the series may be divided into two clearly defined groups or genera. The first of these is composed entirely of species with undivided underleaves and includes the first four of the species described by Spruce under *Odonto-Lejeunea*. For this genus the name *Odontolejeunea* may be retained. In the second genus, which may be designated *Cyclolejeunea*, some of the species have undivided underleaves and others have bifid underleaves. This genus includes most if not all of the remaining species described by Spruce. The slight difference in the underleaves, which by itself would be of but little moment, is supported by the much more important generic characters noted below.

The genus *Odontolejeunea* in its restricted sense is composed entirely of tropical species. The type of the genus, *O. lunulata*, is found in both America and Africa, but the remaining species, so far as known, are exclusively American. Although occasionally found on bark, the species are most at home on living leaves and include some of the largest and most conspicuous of our epiphyllous hepatics. The plants are usually olive green in color, varying to brownish or yellowish, but are apparently never pale green or whitish. In spite of the prostrate habit of the plants, the leaves are not closely appressed to the substratum. When dry they are irregularly crispate and wrinkled; when moist they are convex and strongly revolute along the postical margin. The lobes of the leaves spread widely from the axis and are commonly broad and rounded at the apex. On well-developed leaves the margin is sharply and irregularly dentate, the teeth being scattered and consisting of from one to a considerable number of cells. The lobule of normal leaves encloses a distinct water-sac and the free margin is appressed to the lobe (PLATE 8, FIGURE 2). Along the margin are found from two to four scattered teeth, but the hyaline

papilla instead of being marginal is situated on the antical surface of the lobule at some little distance from the margin (FIGURE 6), very much as Leitgeb describes for "*Phragmicoma*."* A somewhat similar lobule is found in *Brachiolejeunea* and also in some of the species of *Marchesinia*, but it is very different from that found in *Cyclolejeunea* and *Prionolejeunea*. The leaf-cells in *Odontolejeunea* are plane or nearly so and their thin walls are firm and frequently pigmented. Trigones and intermediate thickenings, although small, are everywhere conspicuous (FIGURE 3), but there are no ocelli.

The underleaves in *Odontolejeunea* are approximately orbicular in shape and are commonly described as auriculate at the base. The latter character, however, does not accurately portray the true conditions, because in reality the strongly auriculate appearance is due to the peculiar way in which the underleaves are attached to the axis. The line of insertion is long and sharply arched, and the basal part of the underleaf broadens out so abruptly from this line that it becomes folded upon itself, the fold forming what is apparently the inner edge of a large basal auricle (FIGURE 2). In many cases the lower margin of the underleaf does not extend at all beyond the line of insertion, and of course under these circumstances there is no true auricle whatever; in other cases a slight auricle is developed. The margins of the underleaves are more or less toothed. The radicelliferous discs are highly developed and normally give rise to rhizoids not only from their margins but also from their postical surface. On ordinary underleaves the marginal rhizoids are in a single layer and are more or less palmately branched at their extremities. All of the rhizoids secrete an abundant supply of a tenacious jelly-like substance, a peculiarity possessed by the majority of epiphyllous *Lejeuneae*.

The position of the ♀ inflorescence is variable even in the same species, being sometimes borne on a leading branch and sometimes on a short branch. The inflorescence innovates on one side and frequently the innovation itself is repeatedly floriferous. The lobules of the bracts are represented by minute basal folds (FIGURES 8, 9) and the bracteole is undivided (FIGURE 10). The

* Unters. über Lebermoose, **2**: 14. 1875. Apparently the species studied was *P. Mackaii* (Hook.) Dumort. (= *Marchesinia Mackaii* S. F. Gray).

essential characters of the perianth have already been noted, but it may be added that the lateral keels are distinctly winged and that the teeth are borne on the margins of the wings (FIGURE 1). The ♂ inflorescence consists of a long spike with closely imbricated diandrous bracts, and the corresponding bracteoles are developed throughout its entire length. So far as known the vegetative reproduction is entirely by means of leafy propagula occupying the position of normal branches and comparable with those found in *Leptolejeunea* and *Drepanolejeunea*.

Two species of *Odontolejeunea* are now known from Puerto Rico and each has apparently been collected but a single time. The first of these, *O. lunulata*, was found many years ago by the Italian botanist Balbis, whose specimens are listed in the Synopsis Hepaticarum under *L. tortuosa* Lehm. & Lindenb. These specimens have been examined by Stephani * and also by Schiffner † and are referred by both to *O. lunulata*, of which *L. tortuosa* is now considered a synonym. The other species is *O. Sieberiana* (Gottsche) Schiffn., recently collected by the writer. Since the specimens of Balbis have not been readily accessible, the following description of *O. lunulata* is based largely on Jamaican specimens.

ODONTOLEJEUNEA LUNULATA (Web.) Schiffn.

Jungermannia lunulata Web. Hist. Musc. Hepat. Prodr. 33. 1815.

Jungermannia tortuosa Lehm. & Lindenb.; Lehmann, Pug. Plant. **4**: 50. 1832.

Lejeunea lunulata Nees; G. L. & N. Syn. Hep. 326. 1845.

Lejeunea tortuosa Lehm. & Lindenb.; G. L. & N. Syn. Hep. 327. 1845.

Jungermannia phyllogenides Brid.; G. L. & N. Syn. Hep. 327. 1845 (as synonym).

Lejeunea Martinicensis Lindenb.; G. L. & N. Syn. Hep. 328. 1845.

Lejeunea (*Odonto-Lejeunea*) *lunulata* Spruce, Hep. Amaz. et And. 145. 1884.

Odontolejeunea lunulata Schiffn.; Engler & Prantl, Nat. Pflanzenfam. **I**^{3}: 128. 1893.

* Hedwigia, **27**: 287. 1888.

† Bot. Jahrb. **23**: 596. 1897.

Brownish or yellowish green, scattered or loosely caespitose, often mixed with other *Lejeuneae:* stems 0.17 mm. in diameter, irregularly branched, the branches widely spreading: leaves imbricated, the lobe widely spreading, convex and more or less revolute along postical margin, falcate-ovate, 1.7 mm. long, 1 mm. wide, attached by an almost longitudinal line of insertion, antical margin arching across or just beyond the axis and strongly curved from base to apex, postical margin approximately straight, apex broad and rounded, whole margin sharply dentate, the teeth scattered, each consisting usually of a cell with a strongly thickened outer wall arising from a base two cells wide, postical margin with two teeth much larger than the others and separated from each other by a broad lunulate sinus; lobule suborbicular in outline, 0.35 mm. long, the strongly inflated inner half lying parallel with the axis and bulging beyond the free margin, outer half appressed to lobe, free margin curved from base to end of keel, usually bearing three scattered teeth, two side by side at about the middle of the margin, the other midway between these and end of keel, the teeth blunt, commonly two or three cells long and one or two cells wide at the base, often curved toward the lobe; cells of lobe plane or nearly so, averaging 18 μ at the margin and 30 μ in median and basal regions, walls thin but firm, trigones triangular, rarely confluent, intermediate thickenings numerous, oval: underleaves contiguous or slightly imbricated, broadly orbicular, 0.7 mm. long, 0.85 mm. wide, attached by a narrowly arched line of insertion and apparently strongly biauriculate at base, the auricles subquadrate in form; apex broad and rounded, often revolute; margin sharply denticulate, the majority of the teeth minute and consisting of single projecting cells, one or two teeth in the basal region often larger than the others and broadly triangular in outline: inflorescence dioicous: ♀ inflorescence sometimes on a leading branch, more frequently on a short branch, innovating on one or on both sides, the innovation usually floriferous and sometimes repeatedly so; bracts obliquely spreading, slightly plicate at the very base, ovate to oblong, 0.95 mm. long, 0.6 mm. wide, apex rounded to subacute, margin sharply dentate as in normal leaves; bracteole free, orbicular-obovate, 0.75 mm. long, 0.7 mm. wide, middle portion convex postically with a plane or revolute border, margin irregularly denticulate or dentate with scattered teeth; perianth obovate in outline, 1.25 mm. long, 0.95 mm. wide, cuneate toward base, broad and truncate or slightly retuse at the apex with a distinct beak, antical face plane, postical face with a distinct keel, broad and rounded below, narrow and sharp above, lateral wings extending to or below the middle of the perianth, two or three cells broad, each bearing about twelve sharp and

usually unicellular teeth: ♂ inflorescence terminal on a leading branch or occupying a short branch; bracts in about twelve pairs, imbricated, the lobe ovate, subacute, with three to seven marginal teeth, lobule about half as long as lobe, ovoid, keel arched, free margin involute, the marginal teeth blunt or obsolete; bracteoles imbricated, similar to the underleaves but more shortly inserted, margin varying from entire to minutely crenulate or denticulate: mature sporophyte not seen (PLATE 8, FIGURES 1–15).

On living leaves. Puerto Rico, *Balbis*; these specimens, growing on orange leaves, were probably collected near the coast. Weber describes the type locality of the species as follows: e regionibus tropicis in foliis *Musae*. Although not so stated, his specimens doubtless came from the American tropics where the species is widely distributed. "Oware," * the type locality for *Jungermannia tortuosa*, is the only known African station for the plant.

ODONTOLEJEUNEA SIEBERIANA (Gottsche) Schiffn.

Lejeunea Sieberiana Gottsche; G. L. & N. Syn. Hep. 328. 1845.

Lejeunea (*Odonto-Lejeunea*) *Sieberiana* Spruce, Hep. Amaz. et And. 143. 1884.

Lejeunea (*Odonto-Lejeunea*) *chaerophylla* Spruce, *l. c.* 147. *pl. 21.* 1884.

Odontolejeunea Sieberiana Schiffn.; Engler & Prantl, Nat. Pflanzenfam. 1^3: 127. 1893.

Similar in color and in general appearance to *O. lunulata*: stems about 0.12 mm. in diameter, irregularly branched: leaves imbricated, the lobe widely spreading, convex and more or less revolute along postical margin, falcate-ovate, 1.7 mm. long, 1.2 mm. wide, attached by an almost longitudinal line of insertion, antical margin arching across or just beyond the axis, nearly straight near base, then strongly curved to apex, postical margin approximately straight, apex broad and rounded, whole margin sharply dentate with about twenty scattered teeth, each tooth consisting usually of a cell with a strongly thickened outer wall arising from a base two cells wide, teeth along postical margin somewhat larger than the others but not so discrepant in size as in *O. lunulata*; lobule suborbicular in outline, 0.35 mm. long, inner half inflated but less so than in the previous species, outer half appressed to lobe, free margin curved from base to end of keel,

* "Oware" is apparently the modern "Wari," near the mouth of the Niger.

usually with three or four scattered and equidistant teeth in outer portion, the teeth as in *O. lunulata;* cells of lobe plane or nearly so, averaging 16 μ at the margin, 23 μ in the middle and 30 μ at the base, thin-walled, the triangular trigones and oval intermediate thickenings a little smaller than in the previous species: underleaves distant, 0.6 mm. long, 0.5 mm. wide, obovate, plane or nearly so, apex broad, the apparent basal auricles rounded, margin commonly entire below and varying above from entire to sharply denticulate, the teeth sometimes conspicuous: inflorescence autoicous: ♀ inflorescence borne on a leading branch or on a short branch, innovating on one side, the innovation often floriferous; bracts obliquely spreading, slightly complicate at base, unsymmetrically obovate, 0.95 mm. long, 0.7 mm. wide, margin more sharply dentate than in the leaves, antical margin strongly curved, postical margin nearly straight, apex broad and rounded; bracteole free, orbicular to oblong, about as large as the bracts, margin plane, varying from entire to sharply denticulate; perianth obovate in outline, 1.35 mm. long, 1 mm. wide, broadly cuneate toward base, broad and shortly obcordate at apex with a short beak, antical face plane or nearly so, postical face with a distinct keel sometimes bearing a few short teeth in the upper portion, lateral wings extending almost to the base, two to five cells broad, each about twelve-dentate, the teeth sharp, two to five cells long and usually two cells wide at the base: ♂ inflorescence occupying a short branch; bracts in three to six pairs, imbricated, the lobe ovate, rounded or subacute and apiculate, margin entire or nearly so; lobule as in *O. lunulata*; bracteoles contiguous, oblong to obovate, margin entire: mature sporophyte not seen.

On living leaves. El Yunque, *Evans* (*182*). Also known from the following localities: Andes of Peru and Ecuador, *Spruce;* Mexico, *Liebmann;* Brazil, *Beyrich, Beske, Lindman;* Cuba, *Wright;* Jamaica, *Maxon, Evans;* Dominica and St. Vincent, *Elliott;* Costa Rica, *Pittier.* The type-specimens are said to have been collected on the island of Mauritius, but Stephani looks upon this statement as an error due to the mixing of labels and concludes that Sieber's specimens also came from tropical America. At all events the species has not recently been collected in Africa.

Lejeunea chaerophylla Spruce is here reduced to *O. Sieberiana* on the authority of Schiffner,* who is supported in his statements by Stephani.† Both of these writers examined Sieber's type.

* Nova Acta Acad. Caes.-Leop. **60**: 230. 1893; also Bot. Jahrb. **23**: 588. 1897.
† Hedwigia, **34**: 238. 1895.

According to Stephani, Spruce himself at one time acquiesced in the reduction, but apparently he changed his mind later because in his "Hepaticae Elliottianae," published shortly after his death, it is maintained that both species are distinct.* The specimens of *Lejeunea chaerophylla*, distributed in *Hepaticae Spruceanae*, have entire underleaves and perichaetial bracteoles, and to this extent differ from many of the West Indian forms of *O. Sieberiana*, but as the denticulation of these parts is always variable, this slight difference can hardly be considered sufficient to separate the species.

It will be seen from the descriptions given above that *O. lunulata* and *O. Sieberiana* are very closely related species. The most important difference between them is in the inflorescence, which is monoicous in one and dioicous in the other. Since the plants are rarely sterile this difference can usually be demonstrated. The characters derived from the vegetative organs are subject to so much variation that they must be used with caution in separating the species, and yet, supported by the inflorescence, they are of some importance. The postical margin of the lobe, for example, in *O. Sieberiana* is more regularly dentate than in *O. lunulata* and fails to show the deep and conspicuous sinus between its two middle teeth. The lobule also, in the monoicous species, is less strongly inflated and more regularly denticulate along its free margin, and the leaf-cells have smaller trigones and intermediate thickenings. The underleaves afford differential characters which are a little more reliable than those drawn from the leaves; in *O. Sieberiana* they are rounded and entire in the basal portion, and, if they are dentate at all, the teeth increase in size toward the plane apex; in *O. lunulata* the basal portions often project outward as sharp teeth, while the revolute apex is very minutely denticulate. So far as the writer's experience goes, *O. Sieberiana* is found at rather high altitudes (2,000 feet and above), while *O. lunulata* occurs in the plains; and apparently this difference in habitat has been noted by other observers.

Under the name *Lejeunea* (*Odonto-Lejeunea*) *calcarata*, Spruce† describes a plant from the Amazon to which he doubtfully refers the old *Phragmicoma calcarata* Mont.‡ This species was long

* Jour. Linn. Soc. Bot. **30**: 336. 1894.

† Hep. Amaz. et And. 146. 1884.

‡ Ann. Sci. Nat. Bot. II. **19**: 261. 1843.

ago reduced by Gottsche * to a synonym of *O. lunulata* and was afterwards so regarded by Montagne himself.† Spruce separates his plant on account of the acuminate spurs into which the basal angles of the underleaves are said to be produced. In the specimens distributed in *Hepaticae Spruceanae* this peculiarity is not very clearly exhibited, and many of the underleaves are no more spurred than is usual in *O. lunulata;* it is therefore difficult to form a definite opinion as to the validity of Spruce's species. Judging from the distributed specimens alone the plant is hardly worthy of specific rank.

VEGETATIVE REPRODUCTION IN ODONTOLEJEUNEA

Leafy propagula have been observed by the writer in *O. lunulata* and also in *O. Sieberiana* and are essentially alike in the two species. They are much less abundant than in certain species of *Leptolejeunea* and *Drepanolejeunea* and are apparently never borne on specialized microphyllous branches as is so often the case in those genera. Germinating propagula may readily be found in the vicinity of an older plant, but so far only three cases have been noted in which the propagulum was still attached to the parent axis. In one of these it grew out just behind an ordinary branch-leaf at some distance from the apex of the branch (PLATE 8, FIGURE 12); in the other two cases it occupied a similar position with respect to a bract in the middle of a long antheridial spike. In all three cases the empty sheaths of older propagula could also be demonstrated, and these were always larger and more conspicuous than the basal sheaths of ordinary leafy branches. In two of the cases noted the propagulum arched forward across the axis in such a way as to turn its morphologically postical surface upward, very much as in *Leptolejeunea exocellata;* in the third case the propagulum spread widely from the axis and turned its postical surface downward as in a normal branch.

The first leaf of a propagulum is smaller than the first leaf of an ordinary branch and is obovate in shape (FIGURE 13); it is moreover strongly reflexed and its lobule is practically obsolete, being represented merely by a hyaline papilla. The second leaf

* Syn. Hep. 326. 1845.

† Sylloge, 72. 1856.

is also strongly reflexed but bears a rudimentary lobule; the third and succeeding leaves are similar to ordinary leaves, gradually increasing in size and acquiring normal lobules. The first underleaf is similar to that found at the base of an ordinary branch; it is small and flat, oblong in outline without any indication of basal auricles, and is entire on its margin; it apparently possesses no rhizoid-initials and is attached by a short straight line of insertion. The second underleaf is the most remarkable feature of the propagulum and shows very striking modifications. It is orbicular in shape and is also entire on the margin, but the base is deeply and truly auriculate, the region of insertion being short and at about the middle of the underleaf. The axis-cells, by which the attachment is effected, become elongated and push the underleaf away from the axis, forming as it were a kind of stalk (FIGURE 15). At the top of this stalk the disc is developed and eventually becomes larger than the underleaf itself. The disc consists of two layers of cells, those in the middle being at first small and polygonal in outline and forming a patch about six cells across. The marginal cells, which are really rhizoids, are likewise in two layers and very soon become long and narrow, radiating out in all directions. Instead of remaining distinct, as rhizoids commonly do, they are united except at their tips and thus form, around the middle of the disc, a broad and continuous border crenulated on the edge (FIGURE 14). These rhizoids possess in a marked degree the property of secreting slime. After a propagulum has established itself, the middle cells of the disc may also develop rhizoids. The third and succeeding underleaves of the propagulum are similar to ordinary underleaves and develop radicelliferous discs of the usual type.

CYCLOLEJEUNEA

The genus *Cyclolejeunea* as here understood has four representatives in Puerto Rico. The first of these, *C. Chitonia*, is known from British Guiana and from several of the Lesser Antilles; the second and third, *C. convexistipa* and *C. accedens*, have already been listed from the island * and have a wide distribution in South America; the fourth, *C. angulistipa*, is apparently restricted to

* Hedwigia, 27: 281, 284. 1888.

the West Indies. Even as it stands the extremes of the genus are rather more diverse than is usual in the *Lejeuneae*, and it is possible that it should be still further subdivided; for the present, however, it seems wisest to leave it intact. All of the species of *Cyclolejeunea*, so far as known, are confined to the American tropics and are found on living leaves or on the bark of trees. The genus may be characterized as follows:

Cyclolejeunea gen. nov.

Lejeunea p. p. G. L. & N. Syn. Hep. 1845.

Lejeunea subgenus *Odonto-Lejeunea p. p.* Spruce, Hep. Amaz. et And. 1884.

Lejeunea subgenus *Priono-Lejeunea p. min. p.* Spruce, *l. c.*

Odontolejeunea p. p. Schiffn.; Engler & Prantl, Nat. Pflanzenfam. 1893.

Plants medium-sized to large, sometimes delicate in texture sometimes more robust, varying in color from pale green or whitish to brownish or olive green: stems prostrate and adherent to the substratum, sparingly to copiously branched: leaves contiguous to densely imbricated, the lobe widely spreading, plane or slightly convex, not revolute along the postical margin, falcate-ovate, broad at the apex and usually rounded or apiculate but never acute, margin varying from entire to coarsely and irregularly dentate; lobule inflated and forming a distinct water-sac, keel more or less arched, free margin involute, tipped at the apex by a single cell bearing a marginal hyaline papilla at its proximal base; leaf-cells sometimes delicate and scarcely thickened at the angles, sometimes with distinct trigones and intermediate thickenings; ocelli usually but not invariably present: underleaves approximately orbicular in form, sometimes undivided, sometimes regularly bifid, sometimes undivided or bifid in the same species, attached by a short and scarcely arched line of insertion: inflorescence usually dioicous: ♀ inflorescence borne on a more or less abbreviated branch or on a leading branch, innovating on one side, the innovation sometimes floriferous; bracts unequally bifid, about as large as the leaves, lobule small but usually distinct; perianth strongly flattened but with a distinct postical keel, broad and emarginate above, lateral keels more or less toothed, sometimes winged: ♂ inflorescence occupying a shorter or longer branch; bracts imbricated, diandrous: vegetative reproduction by means of disc-like gemmae borne on the margins of the leaves. (Name from *κυκλος*, a disc, and *Lejeunea*, in allusion to the gemmae).

The most important of the characters which separate the genus just described from *Odontolejeunea* are drawn from the vegetative organs and concern both leaves and underleaves. The margin of the lobe, for example, in *Cyclolejeunea*, is extremely variable with respect to its dentation; in some species it is minutely and regularly crenulate or denticulate from projecting cells (PLATE 10, FIGURES 2, 4); in others it varies from entire to coarsely dentate on the same individual (PLATE 8, FIGURE 16); in *Odontolejeunea* the margin of the lobe is always sharply dentate. The lobule in *Cyclolejeunea* bears a single tooth on the free margin, and the hyaline papilla is also marginal, being borne at the proximal base of this tooth (PLATE 8, FIGURE 22; PLATE 9, FIGURES 10, 17); in *Odontolejeunea* the free margin of the lobule bears several teeth and the papilla is displaced from the margin. The underleaves in the two genera are very different with respect to their method of attachment to the axis, the line of insertion in *Cyclolejeunea* being short and scarcely arched (PLATE 8, FIGURES 16, 17) instead of long and sharply arched as in the other genus. Radicelliferous discs are found in both genera but are not a constant feature in *Cyclolejeunea*, the underleaves in certain species giving rise directly to rhizoids. Other differences in the underleaves, relating to the presence or absence of an apical sinus, have already been alluded to. The perichaetial bracts of *Odontolejeunea* are characterized by being practically elobulate, while those of the new genus have well developed lobules (PLATE 8, FIGURE 23). In the vegetative reproduction, finally, we find a very striking difference which is probably to be considered generic; in *Odontolejeunea* this is carried on by means of the leafy propagula already described; in *Cyclolejeunea* the vegetative reproduction is by means of peculiar marginal gemmae in the form of discs, similar in some respects to those found in *Cololejeunea* and its allies, but differing from them in the details of development and germination. These gemmae will be discussed after the description of species.

Cyclolejeunea Chitonia (Tayl.)

Lejeunea Chitonia Tayl.; Lehmann, Pug. Plant. **8**: 27. 1844 (misprinted "*L. Clitonia*").

Odontolejeunea subbifida Steph. Hedwigia, **35**: 117. 1896.

Brownish or olive green, sometimes varying to pale green or yellowish, densely tufted: stems 0.3 mm. in diameter, copiously and irregularly branched, the branches widely spreading, often ascending: leaves densely imbricated, the lobe more or less convex, broadly falcate-ovate, 1.25 mm. long, 1 mm. wide, attached by an almost longitudinal line of insertion, antical margin arching across or just beyond axis, slightly incurved near base, then strongly outwardly curved to apex, postical margin straight or nearly so, often with a blunt fold near end of keel, apex rounded or obtuse, often apiculate, margin varying from entire to sharply dentate, the teeth in extreme cases reaching a length of four cells and a width of two cells at the base, each tooth tipped with a sharp cell having a strongly thickened outer wall; lobule narrowly ovoid, 0.5 mm. long, 0.2 mm. wide, tapering and more or less curved toward end of keel, strongly inflated, keel slightly roughened from projecting cells, free margin involute to beyond apex, then passing by a shallow and long sinus to end of keel, apical tooth short and somewhat pointed, strongly curved; cells of lobe convex, averaging 18 μ at the margin, 35 μ in the middle and 45 μ at the base, rather thick-walled with large triradiate trigones separated by narrow pits or sometimes by an oval intermediate thickening between two pits; ocelli 80 μ long, 35 μ wide, commonly in a group of three, situated at the base of the lobe but separated from the line of insertion by one or two rows of cells: underleaves imbricated, broadly orbicular, 0.7 mm. long, 0.9 mm. wide, cuneate or subauriculate at the base, shortly bifid at the apex with obtuse or rounded sinus and broad rounded or apiculate lobes, margin varying from entire to sharply and irregularly denticulate in the upper part: inflorescence dioicous: ♀ inflorescence on a short branch, innovating on one side, the innovation commonly floriferous; bracts obliquely spreading, the lobe obovate, 1.25 mm. long, 0.95 mm. wide, margin entire to dentate, the keel sometimes narrowly winged in the lower part, lobule oblong, 0.6 mm. long, 0.25 mm. wide, rounded to acute at the apex, margin entire; bracteole free, obovate, 0.85 mm. long, 0.6 mm. wide, shortly bifid at the apex with connivent obtuse or rounded lobes and narrow sinus, margin entire or nearly so; perianth almost hidden by the bracts, cuneiform in outline with slightly bulging sides, 1.25 mm. long, 0.95 mm. wide, antical face plane, postical keel low and rounded, apex broad and emarginate with an indistinct beak, lateral keels sharp, extended upward as broad, rounded or truncate auricles, entire or minutely and irregularly denticulate in the upper part and often apiculate at the outer angles, sometimes bordered by one or two interrupted and very narrow wings: ♂ inflorescence and mature sporophyte not seen (PLATE 8, FIGURES 16–23).

On bark of trees, more rarely on rotten logs. North slope of the Luquillo Mountains, *Heller* (*1133, 4736 p. p.*). El Yunque, *Evans* (*28, 75, 82, 160*). The species is also known, in sterile condition, from British Guiana, *Greville*, the type-locality, from St. Vincent (collector not named), and from Martinique and Guadeloupe, *Duss.**

C. Chitonia is closely related to **C. Peruviana** (Lehm. & Lindenb.) comb. nov.†, a widely distributed epiphyllous species which is also to be expected in Puerto Rico. In fact the two species are so closely allied that both Spruce ‡ and Stephani § considered them synonymous. The type-specimen of *Lejeunea Chitonia* in the Taylor herbarium is sterile aud rather fragmentary but is clearly the same as the variable plant described above. It would be difficult, however, to gain an accurate idea of the species from the type-specimen alone. *Odontolejeunea subbifida* is a robust and sterile form in which the foliar teeth are less pronounced than usual. The Puerto Rico specimens show all gradations between forms of this type and those in which the leaves are sharply dentate, and in some cases variations of this character are exhibited by an individual plant (FIGURE 16). The striking variability in the teeth seems to be due, at least in part, to differences in the external conditions under which development takes place. When a stem or a branch has plenty of room for growth its leaves become large and the margin tends to be entire or minutely denticulate; when a branch is crowded or limited in its growth for any other reason the leaves are smaller and the margin is more likely to be dentate. The production of gemmae is also correlated with an increase in the size of the teeth. The variability in the teeth affects not only

*Cf. Stephani; Urban, Symb. Ant. **3**: 277. 1902.

† = *Jungermannia Peruviana* Lehm. & Lindenb.; Lehmann, Pug. Plant. **5**: 18. 1832. *Lejeunea Peruviana* Lehm. & Lindenb.; G. L. & N. Syn. Hep. 339. 1845. *Lejeunea* (*Odonto-Lejeunea*) *Peruviana* Spruce, Hep. Amaz. et And. 151. 1884. *Odontolejeunea Peruviana* Schiffn.; Engler & Prantl, Nat. Pflanzenfam. 1^3: 128. 1893.

‡ Hep. Amaz. et And. 152. 1884.

§ Hedwigia, **29**: 70. 1890. Spruce reduced not only *L. Chitonia* to synonymy but also *L. foliorum* Nees (Syn. Hep. 326), and Stephani added *L. adglutinata* Tayl. (Lond. Jour. Bot. **5**: 389. 1846) and *L. epitheta* Tayl. (*l. c.* 395). The type-specimens of the last two species show that while *L. adglutinata* is doubtless the same as *C. Peruviana*, *L. epitheta* is a synonym of *Drepanolejeunea inchoata*, as since pointed out by Stephani himself (Hedwigia, **35**: 83. 1896).

the ordinary leaves but also the underleaves, the lobes of the perichaetial bracts and the lateral keels of the perianth. The development of trigones in the leaf-cells is likewise subject to a great deal of variation. What may be considered a typical condition is described above and figured on the plate (FIGURE 19), but in many cases the trigones are poorly developed and difficult to demonstrate and the walls appear as if they were uniformly thickened. Between these two extremes are all possible gradations.

Aside from its difference in habitat *C. Chitonia* is a more robust plant than *C. Peruviana* and has more densely imbricated leaves and underleaves. The lobe is broad and the lobule narrows gradually toward the end of the keel, the apical sinus being long and very shallow. In *C. Peruviana* the lobe is narrower and usually more gradually pointed, and the lobule narrows more abruptly, the apical sinus being shorter and deeper; in the majority of the leaves there is a distinct angle between the end of the keel and the postical margin of the lobe, and in many cases the outer part of the lobule is curved abruptly backward and forms a sort of tooth at its junction with the lobe, as already described by Spruce. The apical tooth of the lobule in *C. Peruviana* is shorter than in *C. Chitonia* and is scarcely curved. Ocelli are found in both species and the leaf-cells are very much alike, but the walls in *C. Chitonia* tend to be more strongly thickened. The underleaves of *C. Peruviana* are extremely variable, being sometimes undivided and sometimes more or less bifid; and their margins, although usually sharply dentate, are occasionally entire. They tend, however, to be much more toothed than in *C. Chitonia* and when bifid often show acute divisions. On the smaller branches the underleaves are commonly revolute on both sides, a peculiarity rarely seen in the larger species. Spruce describes the perichaetial bracts of *C. Peruviana* as being much smaller than the leaves; this is true of the inner bract only (that next the innovation), the outer bract being of about the same size as the leaves. The same marked inequality occurs also in *C. Chitonia* (FIGURE 23), but the bracteal lobes are broader and the bracteole has blunt instead of acute divisions and seems to be invariably entire. The perianths in the two species are very much alike.

In his original description of *Odontolejeunea subbifida*, Stephani

calls attention to the strong resemblance which it bears in size, color and general appearance to certain members of the genus *Platylejeunea*. He discerned, however, even from his sterile specimens, that this resemblance was merely superficial and that the true alliance of the species was elsewhere, a view which the fertile specimens from Puerto Rico amply confirms. It differs from *Platylejeunea* more especially in its more or less dentate leaves, in its larger and differently constructed lobules, in its bifid underleaves with their short line of attachment, and in its longer ♀ branch with much larger bracts and bracteoles.

Cyclolejeunea convexistipa (Lehm. & Lindenb.)

Jungermannia convexistipa Lehm. & Lindenb.; Lehmann, Pug. Plant. **6**: 43. 1834.

Phragmicoma Surinamensis Mont. Ann. Sci. Nat. Bot. II. **16**: 110. 1842.

Lejeunea convexistipa Lehm. & Lindenb.; G. L. & N. Syn. Hep. 328. 1845.

Jungermannia patinfera Tayl.; G. L. & N. Syn. Hep. 329. 1845 (as synonym).

Lejeunea Surinamensis Mont.; G. L. & N. Syn. Hep. 329. 1845.

Lejeunea Mougeotii Lindenb. & Gottsche; G. L. & N. Syn. Hep. 329. 1845.

Lejeunea (*Odonto-Lejeunea*) *Surinamensis* Spruce, Hep. Amaz. et And. 149. 1884.

Lejeunea (*Odonto-Lejeunea*) *stachyclada* Spruce, *l. c.* 150. 1884.

Lejeunea (*Odontolejeunea*) *convexistipa* Steph. Hedwigia, **27**: 284. 1888.

Odontolejeunea convexistipa Schiffn. Bot. Jahrb. **23**: 583. 1897.

Pale or bright green, growing in thin and intricate mats, often in company with other *Lejeuneae;* stems 0.09 mm. in diameter, copiously and irregularly branched, the branches obliquely or widely spreading, often ascending, usually with smaller leaves than the stem: leaves contiguous or loosely imbricated, the lobe plane or slightly convex, falcate-ovate, 0.75 mm. long, 0.45 mm. wide, attached by an almost longitudinal line of insertion but decurrent at the antical base by a single cell, antical margin arching across or just beyond axis, slightly incurved near base, then strongly outwardly curved to apex, postical margin straight or nearly so, sometimes continuous with the keel but usually with

a slight indentation near junction, apex broad, rounded to subacute, often apiculate by a single sharp cell, margin varying from entire to irregularly crenulate, denticulate or serrulate, each tooth consisting of a single cell; lobule ovoid, 0.17 mm. long, 0.12 mm. wide, strongly inflated, keel more or less arched, smooth or slightly roughened from projecting cells, free margin involute to apex or beyond, sinus lunulate, apical tooth sharp and slightly curved; cells of lobe plane or slightly convex, averaging 16 μ at the margin, 21 μ in the middle and 35 × 21 μ at the base, thin-walled and with small trigones; ocelli commonly two, measuring 45 × 28 μ, situated side by side near the base of the lobe and separated from the line of insertion by a single row of cells: underleaves distant, broadly orbicular, 0.17 mm. long, 0.25 mm. wide, abruptly cuneate at the base, apex broad, rounded or slightly retuse, margin normally entire: inflorescence dioicous: ♀ inflorescence borne on a short branch, innovating on one side, the innovation commonly short and sterile, rarely floriferous; bracts obliquely spreading, the lobe ovate to obovate, 0.65 mm. long, 0.4 mm. wide, margin sharply denticulate, lobule oblong, 0.25 mm. long, 0.1 mm. wide, rounded to subacute at the apex, margin entire; bracteole free, orbicular, 0.4 mm. long, cuneate toward base, margin entire; perianth about half exserted, cuneiform in outline with slightly bulging sides, 0.95 mm. long, 0.7 mm. wide, antical face plane, postical keel broad and rounded, apex broad and emarginate with a short beak, lateral keels sharp, smooth or somewhat roughened from projecting cells, not winged, extended upward as broad, rounded or truncate auricles, usually more or less denticulate in the upper part: ♂ inflorescence usually occupying a long branch; bracts in many pairs (6–22), loosely imbricated, strongly inflated, shortly bifid, the lobe obtuse, often apiculate, margin entire, lobule obtuse, keel strongly arched and often with a crenulate wing one cell broad; bracteoles found throughout spike, distant, oblong, commonly entire: mature sporophyte not seen (PLATE 9, FIGURES 1–16).

On living leaves and on the bark of trees. North slope of the Luquillo mountains, *Heller* (*4326*, *4329*). El Yunque, *Evans* (*7*, *19*, *22*, *55*, *142*, *162*). First collected in Puerto Rico by *Schwanecke* and afterwards found there by *Sintenis* (*4*, *97*). The species is very widely distributed in the American tropics, and two type-localities, St. Vincent and Barbadoes, are recorded by the original authors.

The description of the leaves and underleaves as given above is drawn from those which are normally developed. In many cases, however, the normal branches are largely replaced by short

gemmiparous branches, on which the leaves and underleaves differ materially from those described (FIGURE 4). On these modified branches the leaves are ligulate in form and are not falcate, the two margins being approximately straight and parallel; the apex of the lobe is rounded or truncate and the outer portion is much more coarsely dentate than on ordinary leaves. The cells of the lobe are of about the same size throughout (FIGURE 9). The lobules of these modified leaves become more and more rudimentary on passing from the base of the branch toward the apex and are finally reduced to minute and indistinct basal folds. The underleaves on the gemmiparous branches are close together and more or less squarrose; they are, moreover, strongly convex, and it is probable that the species derived its name from underleaves of this type. The margin in the broad apical region is frequently denticulate, and sometimes the two teeth nearest the middle are larger than the others, thus giving the appearance of a shortly bifid underleaf with a shallow apical sinus. The complicated synonymy of *C. convexistipa* is due largely to the occurrence of these peculiar branches, which sometimes completely mask the true characters of the species; it has been ably elucidated by Stephani.*

The perianth of *C. convexistipa* is also subject to considerable variation, although the form described may be considered typical. In some cases the postical keel is extended upward as a distinct auricle or horn, and in rarer instances an antical keel, also with a horn, makes its appearance. Usually these supplementary horns are shorter than the lateral, but in one observed case they were fully as long and gave rise to a four-horned perianth. The position of the horns, however, was different from what we find in *Ceratolejeunea*, where two of the horns are developed from the upper angles of the postical keel. In other cases the floral leaves, which normally unite to form the perianth, fail to do so properly and leave an incomplete organ. Occasionally the abnormal union expresses itself in the development of irregular wings growing out from the surface of the perianth.

It is not difficult to distinguish *C. Chitonia* from the species just described, although the two are rather closely related. *C. convexistipa* is a smaller plant, much more delicate in texture and usually of a paler color. It differs further in its less crowded leaves and

* Hedwigia, 27: 284. 1888.

underleaves and in the fact that the latter are normally undivided. In the floral organs the differences are not very marked, but the broader perichaetial bracts of *C. Chitonia* and the shortly bifid bracteole may be alluded to in this connection.

Cyclolejeunea accedens (Gottsche)

Lejunea accedens Gottsche ; G. L. & N. Syn. Hep. 339. 1845.

Lejeunea (*Prionо-Lejunea*) *leptocardia* Spruce, Hep. Amaz. et And. 159. 1884.

Lejeunea (*Odontolejeunea*) *accedens* Steph. Hedwigia, **27**: 281. *pl. 14, f. 34–38.* 1888.

Pale green, growing in thin loose mats, often in company with other hepatics: stems 0.1 mm. in diameter, sparingly and irregularly branched, the branches widely spreading, usually with smaller leaves than the stem: leaves imbricated, the lobe widely spreading, plane or nearly so, falcate-ovate, 1.4 mm. long and 1.1 mm. wide on the main stem, attached by an almost longitudinal line of insertion but decurrent at the antical base by a single cell, antical margin nearly straight near base, then strongly curved to apex, postical margin straight or slightly incurved, usually forming a continuous line with keel, apex broad and rounded on stem-leaves, varying to obtuse or subacute on small branches, margin sometimes entire or subcrenulate but usually sharply crenulate or denticulate from projecting cells; lobule ovoid, 0.3 mm. long, 0.2 mm. wide, strongly inflated, keel more or less arched, roughened from projecting cells, free margin strongly involute to beyond apex, sinus short and lunulate, apical tooth blunt and slightly curved; cells of lobe convex except in basal region, averaging 24 μ at the margin, 35 μ in the middle and 45 × 35 μ at the base, each cell bearing a blunt median wart, representing a local thickening of the outer wall, walls otherwise thin, trigones and intermediate thickenings wanting or minute and indistinct; ocelli none: underleaves broadly orbicular, 0.28 mm. long, 0.3 mm. wide, bifid about one half (to within three or four cells of the rudimentary basal disc), with triangular, straight or slightly connivent, acute lobes and obtuse or rounded sinus, margin crenulate or obtusely denticulate from projecting cells: inflorescence autoicous: ♀ inflorescence borne on a leading branch or on a short branch, innovating on one side, the innovation usually sterile or a male flower, more rarely a second female flower; bracts obliquely spreading, the lobe obovate, 0.7 mm. long, 0.37 mm. wide, obtuse or subacute, margin denticulate, lobule oblong, 0.17 mm. long, 0.07 mm. wide, usually blunt, sometimes poorly

developed; bracteole ovate, 0.35 mm. long, 0.25 mm. wide, bifid one third to one half with acute, erect lobes and narrow sinus; perianth projecting slightly beyond the bracts, triangular-obovate in outline, 0.75 mm. long, 0.5 mm. wide, antical face plane, postical keel low and broad, apex emarginate and with a very indistinct beak, lateral keels sharp, extended upward as rounded auricles, lateral wings extending to or below the middle of the perianth, two to six cells broad, denticulate or serrulate on the margin from projecting cells, surface of perianth smooth or somewhat roughened near wings: ♂ inflorescence terminal or occupying a shorter or longer branch; bracts in about six pairs, sometimes more numerous: mature sporophyte not seen (PLATE 9, FIGURES 17–23).

On living leaves. El Yunque, *Evans* (*21 p. p.*). Also collected by *Schwanecke*. Other stations for the species are the following: St. Kitts, *Breutel*, the type-locality; Guadeloupe, *Husnot;* Dominica and St. Vincent, *Elliott;* Peruvian Andes, *Spruce;* Bolivia, *Rusby*.

The identity of *Lejeunea leptocardia* with *C. accedens* was provisionally acknowledged by Spruce when he distributed his exsiccatae, and was afterward affirmed more positively by Stephani.* There is certainly no essential difference between the specimens in the *Hepaticae Spruceanae* and those collected on El Yunque. The generic position of the species is a little uncertain, because it approaches *Prionolejeunea* so closely, as has already been noted. It is here separated from *Prionolejeunea* and placed in *Cyclolejeunea* on account of its prostrate habit, the rounded lobes of its leaves, the different cell-structure, the longer female branch and the marginal discoid gemmae.

The cell-walls of *C. accedens* are so transparent that it is sometimes difficult to demonstrate the tubercles on the leaf-cells except along the margin. In doubtful cases staining with methyl-blue will show whether they are present or not. The occurrence of these tubercles is of course a somewhat aberrant character for the genus and would be equally aberrant for either *Prionolejeunea* or *Odontolejeunea;* it indicates a certain relationship with *Trachylejeunea*, to which, however, *C. accedens* cannot belong on account of its flattened, emarginate perianth.

There is no Puerto Rico species except the following with which *C. accedens* is likely to be confused. From *C. convexistipa*,

* Hedwigia, **35**: 120. 1896.

which it resembles in size and color and in the nature of its gemmae, it may at once be distinguished by its exocellate leaves, by its regularly bifid underleaves, by its autoicous inflorescence and by its winged perianth. Most of these characters will also separate it from the much more robust *C. Chitonia*.

Cyclolejeunea angulistipa (Steph.)

Lejeunea angulistipa Steph. Hedwigia, **29**: 69. 1890.
Prionolejeunea angulistipa Steph. *l. c.* **35**: 118. 1896.

Pale yellowish or whitish green, becoming brownish upon drying, loosely tufted: stems 0.09 mm. in diameter, less closely adherent to the substratum than in the other members of the genus, sparingly and irregularly branched, the branches widely spreading: leaves loosely imbricated, the lobe abruptly dilated from a narrow base, widely spreading (in outer part), broadly falcate-ovate, 0.5 mm. long, 0.45 mm. wide, attached by an almost longitudinal line of insertion, but decurrent at the antical base by a single cell, antical margin straight or slightly incurved near base, then strongly outwardly curved to apex, postical margin straight or somewhat outwardly curved, forming an angle of 90° or more with keel, apex broad, rounded to obtuse, margin minutely and regularly crenulate or denticulate from projecting cells, except close to the antical base; lobule ovoid, 0.17 mm. long, 0.1 mm. wide, much inflated, keel strongly arched, more or less roughened from projecting cells, free margin strongly involute to apex, sinus broad and lunulate, apical tooth curved and rather sharp; cells of lobe slightly convex, averaging 16 μ at the margin, 25 μ in the middle and 32 × 25 μ at the base, rather thick-walled, the triangular trigones and the occasional intermediate thickenings large and conspicuous; ocelli when present one to four in number, measuring 50 × 35 μ, situated near the base of the lobe, but separated from the line of insertion by one or two rows of cells: underleaves distant, orbicular or rhombic-orbicular, 0.14 mm. long, bifid about one half (to within two or three cells of the radicelliferous region) with triangular, acute and erect lobes separated by an acute to obtuse sinus, margin entire or subcrenulate, often angular-dentate on the sides: inflorescence dioicous: ♀ inflorescence borne on a leading branch, more rarely on a short branch, innovating on one side, the innovation commonly branched and sometimes floriferous; bracts obliquely spreading, the lobe obovate, unsymmetrical, 0.45 mm. long, 0.3 mm. wide, rounded at the apex, entire or subcrenulate, lobule oblong to lanceolate, 0.2 mm. long, 0.08 mm. wide, margin as in lobe; bracteole free, obovate from a narrow base, 0.45 mm. long, 0.3

mm. wide, bifid from one third to one half with triangular, erect or connivent, acute to obtuse lobes separated by a narrow sinus, margin as in bracts; perianth about half exserted, cuneiform in outline with nearly straight sides, 0.85 mm. long, 0.7 mm. wide, antical face plane, postical keel low and broad, apex slightly emarginate and with a short beak, lateral keels sharp, extended upward as rounded, very narrowly bialate auricles, the wings sharply denticulate with unicellular teeth: ♂ inflorescence occupying a short branch or terminal on a longer one, sometimes proliferating from the apex; bracts in six pairs or less, contiguous or loosely imbricated, strongly inflated and slightly bifid, the lobe more or less pointed and slightly denticulate, the lobule blunt and entire, keel strongly arched and narrowly winged in outer part, the wing crenulate and composed of a single row of cells; bracteoles present in the lower part of the spike, similar to the underleaves, but smaller: mature sporophyte not seen (PLATE 10, FIGURES 1–17).

On bark of trees and on logs. North slope of the Luquillo Mountains, *Heller* (*4716*, *4738*, *4743 p. p.*). Also known from Martinique, *Perrottet*, and recently collected by the writer in Jamaica. The type-locality is not definitely indicated by Stephani.

C. angulistipa is about as close to *Prionolejeunea* as the preceding species and is placed in *Cyclolejeunea* for essentially the same reasons. The cell-structure, however, in the present species would hardly separate it from *Prionolejeunea*, and the female branch, although normally long, is sometimes much abbreviated. The leaves, on the other hand, are usually conspicuously ocellate, and the marginal gemmae are very abundantly produced, being found occasionally even on the perichaetial bracts; both of these peculiarities indicate an alliance with *C. convexistipa*, although the gemmae are somewhat different in the two species. As in other species of doubtful generic affinity, the position of *C. angulistipa* must be determined from a combination of characters rather than from a single generic difference, and another writer might decide in favor of *Prionolejeunea* without violating the natural relationships of the plant.

C. angulistipa is a smaller plant than *C. accedens* but is at the same time more robust on account of its thicker cell-walls and conspicuous trigones. The leaves are further distinguished by being ocellate and by the fact that their cells, although convex, lack the peculiar tubercles found in *C. accedens*. In the inflores-

cence and floral organs there are also important differences, *C. accedens* being autoicous instead of dioicous and developing much broader wings on the lateral keels of the perianth. The two species differ finally in place of growth, *C. angulistipa* being found on bark while *C. accedens* prefers living leaves.

Among the species of *Prionolejeunea*, *P. microdonta*, which has not yet been reported from Puerto Rico, resembles *C. angulistipa* in its general appearance, in its blunt leaves, in its subfloral innovations, and in the characters of its perianth. The leaves of *P. microdonta*, however, are more delicate in texture, more sharply denticulate and are usually exocellate, although Spruce apparently attributes ocelli to the species.* It differs further in its autoicous inflorescence and in its normally abbreviated female branch, as well as in its lack of gemmae.

VEGETATIVE REPRODUCTION IN CYCLOLEJEUNEA †

According to Cavers,‡ discoid gemmae have been recorded in *Radula*, *Porella*, *Frullania* and the following genera of the *Lejeuneae*: *Metzgeriopsis*, *Colurolejeunea*, *Cololejeunea*, *Lejeunea* and *Odontolejeunea*. To these *Diplasiolejeunea* may be added, and it is probable that further study will lengthen the list still more. Under the genus *Odontolejeunea* the only species mentioned is *O. mirabilis* Steph. ms., which we know merely from one of Goebel's figures representing a single gemma.§ Judging from this figure alone the species should be referred to *Cyclolejeunea* rather than to *Odontolejeunea*, the method of attachment of this gemma being the same as in *C. Peruviana*. The source of most of our information on these interesting reproductive bodies is Goebel's paper on "epiphytische Farne und Muscineen," ‖ which was based largely on specimens collected in Java.

In the species of *Cyclolejeunea*, studied by the writer, the gemmae are all composed of a single layer of cells. Each gemma is borne on a marginal leaf-cell, which projects slightly beyond the

* Hep. Amaz. et And. 158. 1884.

† A short account of the vegetative production in *Cyclolejeunea* was read before the Society of Plant Morphology and Physiology, Philadelphia, December, 1903. Abstract in Science, II. 19: 415. 1904. The undescribed species referred to is *C angulistipa*.

‡ New Phytol. 2: (15)–(20). 1903.

§ Organographie der Pflanzen, 277. *f. 175, I.* 1898.

‖ Ann. Jard. Buitenzorg, 7: 1–73. *pl. 1–9.* 1887.

other cells and functions as a stalk. The gemma is attached to the stalk-cell by two basal cells which can usually be distinguished by their greater length. The separation of the gemmae is by a schizolytic process, which leaves intact both the stalk-cell and the two basal cells of the gemma. The development, structure and germination of the gemmae differs somewhat in the various species and will be described in considerable detail.

In *Cyclolejeunea accedens*, which will be taken up first, the gemmae arise normally from the antical margin of an unmodified leaf. One of the pointed marginal cells bulges slightly beyond its neighbors and becomes enlarged at its extremity. The enlarged portion is then cut off by a wall and forms the mother-cell of the future gemma (PLATE 9, FIGURE 18). The wall cutting off the mother-cell is not at right angles to the surface of the leaf but is oblique to it and lies in such a way that the cell cut off partly overlaps the stalk-cell when looked at from above. The mother-cell then divides into two unequal cells by a second oblique wall and this is cut by a third oblique wall. The young gemma now consists of three cells: two of these, the basal cells, connect the gemma with the stalk-cell and apparently undergo no further divisions; the third is a wedge-shaped cell, entirely free from the stalk-cell and beginning at once to function as an apical cell. As the development of the gemma continues, the basal cells lengthen and grow back over the surface of the leaf, in this way displacing the region of attachment to the stalk-cell until it comes to lie at some little distance from the margin of the gemma on its ventral surface (FIGURES 19, 20). While these changes are going on in the basal cells, the apical cell is undergoing a series of rapid divisions and soon gives rise to a circular cell-layer composed of a considerable number of small cells. In the subsequent growth of the gemma these cells increase markedly in size, but their growth is apparently unaccompanied by further cell divisions, the apical cell itself eventually becoming indistinguishable from the other marginal cells (FIGURE 21).

The adult gemma is not flat but is shaped very much like a watch-glass and lies with its convex surface turned toward the leaf. The cells composing it show very little differentiation, but the marginal cells are a little smaller than the others and their

walls are more delicate. Two of the marginal cells, during the development of the gemma, lengthen out into unbranched rhizoid-like structures, which ultimately become a little longer than its radius. These cells lie, one on each side, about midway between the apical cell and the base of the gemma, and their outgrowths are more or less closely appressed to its convex lower surface (FIGURE 21). Apparently none of the marginal cells are modified into the curious organs of attachment, which Goebel describes and figures for *Cololejeunea Goebelii.*

When a gemma becomes detached it must fasten itself firmly to the substratum before further development can take place. This is done by means of radiately branched rhizoids, which spring from the marginal cells and secrete an abundant supply of slime. Apparently all of the marginal cells are able to develop rhizoids of this character, but many of them fail to do so. The number and position of the rhizoids varies accordingly on different gemmae (FIGURES 22, 23). In all cases observed, where a gemma had established itself firmly, it had first of all been turned over and had thus been enabled to present its concave surface to the substratum; but whether or not this is an absolutely necessary proceeding could only be proved by experiment. In any case the gemma would be in a most unstable position if it lay with its convex surface turned toward the substratum, and this instability would be increased rather than diminished by the two long rhizoid-like outgrowths above described. By turning the concave surface downward, on the other hand, the gemma is able to present its entire circumference to the substratum and at the same time to enclose a capillary space where water can be temporarily retained. Through the inversion of the gemma the surface which was originally ventral becomes dorsal, and apparently the two outgrowths, which are now turned away from the substratum, undergo no further development. These structures, therefore, although without doubt morphologically rhizoids, do not assume the function of holding the gemma in place.

The established gemma does not give rise at once to a leafy axis but develops instead a protonemal structure in the form of a flat oblong or ligulate thallus, closely appressed to the substratum (FIGURES 22, 23). Its behavior, therefore, is very much

like that of the two Javan species of *Radula, R. Hedingeri* and *R. Tjibodensis*, described by Goebel.* In order to distinguish a protonemal structure of this type from the similar protonemata sometimes found in spore-germination, Schiffner† proposes the term "Brutknospenvorkeim" or "gemmothallium," which well expresses the facts in the case. In the gemmae of *C. accedens* the gemmothallia may apparently arise from any part of the margin. In the majority of cases, however, the apical region is favored, and it is possible under these circumstances that the old apical cell reassumes its function of dividing and becomes the apical cell of the gemmothallium. Next to the apical region one of the two basal cells seems to be the favorite starting-point for the new structure, and in some cases two or more gemmothallia may be found on a single gemma (FIGURE 23). From whatever region it arises the gemmothallium grows by means of a two-sided apical cell and finally equals or surpasses in size the original gemma. It affixes itself to the substratum by means of rhizoids like those found on the gemma, but owing to its flat character these rhizoids are not confined to the margin but can grow out from any part of the ventral surface. The apical cell of the gemmothallium eventually becomes the apical cell of the leafy shoot. This gives rise at first to two very rudimentary leaves unaccompanied by an underleaf; the third and fourth leaves, however, begin to show the foliar characters of the species and are accompanied by an underleaf in the ordinary way.

The gemmae of *C. convexistipa* are very similar to those of *C. accedens* and are attached to the leaf by two basal cells in the same way. They are, however, larger and commonly bear three or four unbranched marginal rhizoids instead of two. They are distinguished further by a persistent apical cell which can be readily demonstrated in a mature gemma (FIGURE 14). Here again the gemma is normally inverted before it germinates; it also affixes itself to the sustratum by means of rhizoids springing from its marginal cells. These rhizoids, however, do not arise from the ventral surface of the marginal cells as in *C. accedens* but from the outer edges, and are usually less branched (FIGURE 16). The gemmae of *C. convexistipa* do not develop gemmothallia but

* Ann. Jard. Buitenzorg, **7**: 51–54. *pl. 6, 7. f. 60–67.* 1887.

† Oesterr. Bot. Zeits. **43**: 207. 1893.

grow at once into leafy shoots, the two-sided apical cell of a gemma becoming directly the tetrahedral apical cell of a new axis (FIGURE 15). Apparently a gemma never develops more than one leafy shoot. In their structure and germination the gemmae just described bear much resemblance to those of *Radula complanata*, of which we have an account by Cavers.* In both *Radula* and *Cyclolejeunea*, therefore, the gemmae of certain species produce gemmothallia, while those of other species fail to develop these remarkable structures. In *C. Chitonia* the gemmae are essentially like those of *C. convexistipa* and consequently retain their apical cells; in many cases, however, they lack the unbranched marginal rhizoids. Germination in this species has not been observed. In *C. Peruviana* the gemmae also retain their apical cells, but the region of attachment, through the division of the basal cells, is displaced toward the center of the gemma instead of being marginal.

The gemmae of *C. angulistipa* differ in several important respects from those found in other species of *Cyclolejeunea*. As in *C. accedens* one of the marginal cells of a leaf projects beyond its neighbors (PLATE 10, FIGURE 10) and is divided by a wall into a stalk-cell and the mother-cell of the future gemma. The dividing wall, however, is at right angles to the surface of the leaf. The mother-cell then divides by a longitudinal wall into two equal cells situated side by side (FIGURE 11). In each of these cells the succeeding divisions go on independently. The cell first divides into an inner and outer cell by a wall at right angles to the longitudinal wall (FIGURE 12). The inner cell may or may not undergo a few irregular divisions. The outer cell behaves at once like an apical cell and continues to cut off segments for a considerable time (FIGURES 13, 14). The adult gemma is flat and ligulate in form, lying in the same plane as the leaf and parallel with its margin (FIGURES 9, 15). The stalk-cell is attached at the bottom of a distinct depression, and the two basal cells are indistinguishable except by their position. If a plane is passed through the stalk-cell and at right angles to the surface of the leaf, it will cut the gemma into symmetrical halves, each of which has developed from one of the two cells resulting from the original division of the mother-cell. The marginal cells are scarcely different from the others, but a few of them give rise to long spreading rhizoids lying

* New Phytol. 2: (18). 1903.

in the plane of the gemma. The two apical cells, which are of course marginal cells as well, are persistent and can easily be distinguished at the ends of the gemma. Occasionally an unsymmetrical gemma may be observed, and this is usually caused by the arrested development of one of the apical cells. There is at present no evidence whatever that the adult gemmae are dorsiventral, a condition which is apparently found in *C. accedens* and *C. convexistipa*.

Owing to the habitat of *C. angulistipa* — on rough bark — the marginal rhizoids are usually sufficient to hold the gemmae in place when they become separated from the parent plant; sometimes, however, a few supplementary rhizoids are produced. The germination does not always follow the same type. In cases which may be considered the more typical, one of the apical cells gives rise at once to a leafy shoot without the interpolation of a gemmothallium (FIGURE 16). In other cases a long strap-shaped gemmothallium is developed, which may or may not produce other structures of the same sort by proliferation (FIGURE 17). The growth of the gemmothallium is by means of a two-sided apical cell, and this is probably directly derived from the similar cell of the original gemma. When proliferation takes place the secondary gemmothallia may grow out from the apex of the primary one or from other parts of its margin. In *C. angulistipa*, therefore, the two types of germination which are described above are both exhibited.

The processes of vegetative reproduction in this species may be still further complicated. The gemmothallium, for example, may itself give rise to gemmae of the ordinary type, resembling in this respect the highly developed protonema or gemmothallium of *Metzgeriopsis*.* In other cases a leaf-cell may grow out into a thalloid structure with a single apical cell, from which a leafy shoot eventually develops. This is doubtless an example of a protonema growing directly from a vegetative cell instead of from a spore and resembles the cases described and figured by Goebel.† A protonema of this type is scarcely to be distinguished by its appearance from a gemmothallium.

* Cf. Goebel, Ann. Jard. Buitenzorg, **7**: 55. *pl. 7. f. 72.* 1887; also Schiffner, Oesterr. Bot. Zeits. **43**: 121. *pl 7. f 1.* 1893.

† Flora, **72**: 17. *pl. 1, f. 19.* 1889.

PRIONOLEJEUNEA

The genus *Prionolejeunea* comprises a group of closely related species, all of which are found in moist tropical forests. It attains its highest development in America, but a few species from western Africa have recently been described. No species are known with certainty from Asia or from the islands of the Pacific. In their choice of a substratum the species are much less particular than in either *Odontolejeunea* or *Cyclolejeunea*. Some of them occur on rocks, others on rotten logs or on trees, still others on the roots and bases of tree ferns; in some cases the same form may be found on various substrata. Nearly all of them show a tendency to creep over tufts of larger mosses and hepatics, and it is most unusual to find a patch composed of a single species free from admixture of any sort.

The species are all small and delicate and are pale green or yellowish in color. The characters derived from the leaves are extremely uniform throughout the genus. The lobe spreads widely from the axis and is attached, very much as in *Harpalejeunea*, by an almost longitudinal line of insertion decurrent by a single cell. Just beyond the lobule the lobe is abruptly dilated into a broadly ovate or orbicular expansion (PLATE 11, FIGURES 2, 19), the margins both antical and postical being more or less rounded. At the apex it is usually abruptly acute or apiculate but is sometimes obtuse or even rounded, and there is often considerable variation in these respects even in a single specimen. The middle part of the lobe is convex but the margin is plane and appressed to the substratum, thus leaving a small capillary space underneath the lobe. Except in a single species the margin of the lobe is distinctly crenulate or denticulate. Each tooth is commonly a single projecting cell (PLATE 10, FIGURE 22; PLATE 11, FIGURE 21); in some cases every marginal cell forms a tooth of this character, in other cases the teeth are separated from one another by cells which do not project: sometimes a few of the teeth will be larger than the others and composed of two or three cells apiece. The denticulation of the leaves is subject to a great deal of variation even on a single individual, and the characters derived from the marginal teeth must therefore be used with the utmost caution in distinguishing between near allies.

The leaf-cells also exhibit considerable uniformity. The outer wall of each cell is usually more or less convex, making the surface of the leaf slightly roughened and approaching in this respect the genus *Trachylejeunea*; but the convex wall is not thickened except sometimes on the marginal teeth. Trigones and intermediate thickenings, although varying greatly in size, can almost always be demonstrated (PLATE 10, FIGURE 21). Ocelli are absent from all the Puerto Rico species and it is doubtful if they occur anywhere in the genus.

The lobule is built up on essentially the same principle as in *Harpalejeunea* and *Cyclolejeunea*. It has a strongly arched keel, more or less roughened throughout, and the free margin is tipped with a single curved cell (PLATE 10, FIGURE 24), which is normally appressed to the lobe and thus assists in forming the opening into the well-developed water-sac. The hyaline papilla is proximal in position, but the depression in which it is situated is very shallow or even entirely obsolete. The papilla itself is conspicuous and lies parallel with the free margin, very much as in *Hygrolejeunea* and *Taxilejeunea*. Sometimes a lobule is poorly developed and fails to show some of the characters just enumerated.

The underleaves, which are very much like those of *Trachylejeunea*, are usually small and distinct and vary in shape from broadly ovate to orbicular. They are deeply bifid with triangular lobes separated by a broad sinus. The rhizoids when present grow out from a definite patch of thin-walled cells at the base of the underleaf (PLATE 11, FIGURE 9), and sometimes an extremely rudimentary disc is developed. The radicelliferous region is separated from the base of the sinus by from one to three cells and is bounded on each side by a single large cell. The line of insertion is short and scarcely arched. The margin of the underleaf is usually entire or crenulate but is sometimes angular-dentate on the sides.

In the majority of the species the inflorescence is autoicous but in a few it is dioicous. The female branch is extremely short and rarely bears more than a single rudimentary leaf and a single underleaf in addition to the involucre and perianth. Occasionally a single pair of normal leaves with their underleaf is interpolated between the rudimentary leaf and the bracts (PLATE 11, FIGURE 18), but this condition seems to be unusual and is limited to certain

species. In most of the species the female branch is simple; in a few it is subtended by a short sterile or male innovation; and a very few species have been described in which both conditions are found.

One of the most characteristic features of the genus is the perianth, which, however, finds its counterpart in *Odontolejeunea*, in *Cyclolejeunea* and in certain species of *Cololejeunea*. This organ broadens out gradually from a narrow base and varies at the apex from truncate to emarginate. The apical beak is short or obsolete. The perianth in most of the species is strongly compressed with sharp lateral keels and a broad and rounded postical keel. The lateral keels are usually provided in the upper part with two narrow and interrupted, denticulate to laciniate wings. The characters derived from the floral organs are the most reliable in distinguishing the species of this difficult genus, and it is rarely advisable to attempt the determination of material which is wholly sterile.

Taking the genus as a whole it shows a close relationship with *Cyclolejeunea* and *Trachylejeunea*. From the first of these it differs in its general habit, in its invariably short female branch, and in its lack of gemmae. In fact, so far as is known at present, no species of *Prionolejeunea* exhibits specialized organs of vegetative reproduction, although in one or two cases flat protonemata have been observed growing out from ordinary leaf-cells. The absence of ocelli will also separate the present genus from most of the species of *Cyclolejeunea*. When compared with *Trachylejeunea* the resemblance in leaves and underleaves is at once apparent, even the lobules being built up on the same type in the two genera; but *Trachylejeunea* is amply distinct in its inflated, five-keeled perianth.

Only one species of *Prionolejeunea*, *P. denticulata* (Web.) Schiffn.,* has been recorded from Puerto Rico. This was found in the collection of Schwanecke, and the old determination of Hampe and Gottsche † has recently been confirmed by Schiffner.‡ Unfortunately the original *Jungermannia denticulata* of Weber § is shrouded in so much mystery that it is impossible to state definitely just which modern species or group of species it represents. The original description does not help at all; it merely gives a

* Engler & Prantl, Nat. Pflanzenfam. 1^3: 127. 1893.

† Linnaea, **25**: 354. 1852.

‡ Bot. Jahrb. **23**: 585. 1897.

§ Hist. Musc. Hepat. Prodr. 30. 1815.

very brief characterization of the leaves and underleaves and would apply to almost any species of *Prionolejeunea* or even to species of other genera of the *Lejeuneae*. Weber's description of the type-locality is also indefinite; it is given as follows: ad *Trichom. rigidum* ill. Sprengel. observavit, et absque nomine olim communicavit. Later references to Weber's type-specimens are both vague and confusing. Under *Lejeunea denticulata* Nees, in the Synopsis Hepaticarum, the first specimen quoted is from the following locality: ad *Trichomanes radicans* Jamaicae (Spreng. in Hb. Web.); this is the only specimen noted from the Weber herbarium and also the only one under which reference is made to Sprengel. It was presumably determined by Weber himself even if it did not represent a part of his type-material. In Stephani's paper on "Die Gattung *Lejeunea* im Herbarium Lindenberg," two specimens are quoted under *L. denticulata*,* either of which might be a part of Weber's type, although no definite statement to this effect is made. The first of these is No. 6277, "ad. *Trichom. rigid.*"; the second is No. 6278, "Patria? Sprengel." According to Stephani neither of these is the true *L. denticulata* as he understands the species: the first becomes the type of his new *L. angulistipa*; the second is sterile and indeterminable, but is also distinct. Whether he studied the Jamaican specimen referred to in the Synopsis does not appear from his writings, and there are apparently no later references of any sort to Weber's specimens. The only fact to be learned from the evidence just submitted is that *Jungermania denticulata* was probably an aggregate and that it may have included other forms than those mentioned by Stephani. Under the circumstances it seems wisest to allow the name to disappear from the literature. This conclusion is supported by the fact that recent writers have applied the name *L. denticulata* to entirely distinct species. The plant described † and distributed by Spruce, for example, is destitute of subfloral innovations, while in a specimen from Guadeloupe, determined by Gottsche and kindly communicated by Stephani, innovations are present and the leaves present a different cell-structure. The specimens collected by Schwanecke have not been examined by the writer.

* Hedwigia, **29**: 69. 1890.

† Hep. Amaz. et And. 156. 1884.

In the following pages five species of *Prionolejeunea* from Puerto Rico are described. One of these is *P. aemula* (Gottsche), already known from two of the Lesser Antilles; the others are apparently new. It is probable that further exploration of the island would increase the list of species very materially, since several sterile and indeterminable forms occur in the collections already made. It is also probable that the geographical distribution of one or more of the new species will eventually be found to extend into the neighboring islands.

Prionolejeunea innovota sp. nov.

Dull yellowish green, becoming brownish upon drying, loosely and intricately caespitose: stems 0.09 mm. in diameter, prostrate and loosely adherent to the substratum, sparingly branched, the branches obliquely to widely spreading: leaves contiguous or subimbricated, the lobe widely spreading, more or less convex, falcate, 0.35 mm. long, 0.3 mm. wide, outer part ovate-orbicular, abruptly dilated from a narrow basal region, antical margin straight or slightly incurved near base then strongly outwardly curved to apex, postical margin also strongly curved, apex broad, apiculate or abruptly acute, whole margin (except close to the antical base) sharply denticulate from projecting cells, the teeth regular except in the apical region; lobule ovoid, 0.15 mm. long, 0.1 mm. wide, inflated throughout, keel arched, forming a distinct angle of 90° or more with postical margin of lobe, free margin involute to beyond apex, sinus short and lunulate, apical tooth rather sharp and distinctly curved; cells of lobe slightly convex, averaging 14 × 16 μ at the margin, 28 μ in the middle and 35 × 23 μ at the base, walls rather thin, the trigones and the occasional intermediate thickenings small and sometimes indistinct[1]; underleaves distant, orbicular, 0.15 mm. long, bifid one half to two thirds (to within two or three cells of the radicelliferous portion) with erect, triangular and acute lobes separated by a broad, acute to lunulate sinus, margin usually with one or two short angular teeth on each side, otherwise entire: inflorescence autoicous: ♀ inflorescence on a very short branch, innovating on one side, the innovation sometimes short and sterile, sometimes an antheridial spike; ♀ bracts widely spreading, the lobe obovate, 0.5 mm. long, 0.3 mm. wide, rounded, apiculate or acute at the apex, margin almost as in the leaves but the teeth sometimes a little more irregular, lobule oblong to lanceolate, 0.2 mm. long, 0.12 mm. wide, blunt or acute at the apex, margin entire or slightly denticulate; bracteole free, broadly ovate or orbicular-ovate, 0.35 mm. long, 0.3 mm. wide, bifid about one half with acute, erect or con-

nivent lobes and narrow sinus, margin slightly and irregularly crenulate or denticulate from projecting cells; perianth well exserted, broadly triangular in outline with nearly straight sides, 0.75 mm. long, 0.55–0.65 mm. wide, postical keel low and broad, apex slightly but distinctly emarginate with a very indistinct beak, lateral keels extended upward as rounded auricles, bearing above the middle two narrow and interrupted wings, sharply and irregularly denticulate to laciniate on the margin, the teeth one to four cells long and one to three cells broad at the base, surface of perianth smooth or a little roughened from projecting cells, the postical keel sometimes more markedly scabrous in the upper part: ♂ inflorescence occupying a short branch; bracts in two to six pairs: mature sporophyte not seen (PLATE 10, FIGURES 18–27).

On roots of a tree fern. North slope of the Luquillo Mountains, *Heller (4637)*.

The perianth of *P. innovata* varies considerably in width and is sometimes quite a little broader than in the specimen figured. It is further remarkable for the distinct teeth which are often to be observed in the upper part of the postical keel; in one case noted the keel was obscurely two-angled and the teeth were arranged along the angles.

So far as is known at present this is the only species on the island in which subfloral innovations are developed. Its immediate allies, therefore, must be sought among species from other regions. Apparently the closest of these is *Lejeunea* (*Priono-Lejeunea*) *macrocardia* Spruce,* from the Peruvian Andes, in which the inflorescence is also autoicous. In this species, however, the leaves are blunter and are sometimes obtuse or even rounded, the marginal denticulations are less prominent, the underleaves are entire except for the apical sinus, the margins of the bracts are no more sharply toothed than in the leaves, and the perianth is more deeply and narrowly emarginate. No other described species seem to be very close. *P. microdonta*, *P. subobscura* Spruce † and *P. validiuscula* Spruce † have subfloral innovations and are also autoicous, but all three species are more robust than *P. innovata*, their leaves are usually even blunter than in *L. macrocardia* and their underleaves are also destitute of marginal teeth. These three plants were originally described from South American specimens, but *P. microdonta* has been recorded from St. Vincent and *P. validiuscula* from

* Hep. Amaz. et And. 158. 1884.

† Stephani, Hedwigia, 35: 119. 1896.

the same island and also from Dominica; their discovery therefore may be expected in Puerto Rico. Judging from the description alone, another species from St. Vincent, *Prionolejeunea vagans* (Spruce) Schiffn.,* resembles *P. innovata* rather closely in the form and denticulation of its leaves and also agrees with it in the possession of a subfloral innovation. It differs, however, in the more conspicuous trigones of its leaves, in its dioicous inflorescence and in its indistinctly winged perianth, the wings being merely setulose or erose and never laciniate.

There will be little difficulty in distinguishing *P. innovata* from *Cyclolejeunea angulistipa*, although in both species the underleaves are commonly toothed on the sides. The *Cyclolejeunea* is more robust in all its parts, the cell-walls being firmer and their local thickenings much more pronounced, the leaves are blunt and usually ocellate, the inflorescence is dioicous, the female branch is variable in length and the wings of the perianth are narrower and more shortly denticulate. Of course the remarkable gemmae afford a further character of much importance and these can usually be demonstrated without difficulty.

Prionolejeunea aequitexta sp. nov.

Dull yellowish green, becoming brownish upon drying, loosely and intricately caespitose, often mixed with other hepatics: stems 0.09 mm. in diameter, prostrate and loosely adherent to the substratum, sparingly branched, the branches obliquely to widely spreading: leaves contiguous to loosely imbricated, the lobe widely spreading, plane to convex, falcate, 0.5 mm. long, 0.4 mm. wide, outer part ovate-orbicular, dilated from a narrower basal region, antical margin straight or slightly incurved near base, then strongly outwardly curved to apex, postical margin also strongly outwardly curved, forming an angle of 90° or less with the keel, apex broad, abruptly acute or apiculate, rarely reflexed, whole margin (except close to the antical base and near keel) closely and often regularly denticulate or serrulate from projecting cells; lobule inflated throughout, ovoid, 0.17 mm. long, 0.1 mm. wide, keel strongly arched, free margin straight or nearly so, involute to beyond apex, sinus lunulate, apical tooth rather sharp and slightly curved; cells of lobe convex, averaging 15 μ at the margin, 19 μ in the middle and 30 × 19 μ at the base, rather thin-walled but with conspicuous trigones and intermediate thickenings: underleaves

* Bot. Jahrb. **23**: 590. 1897 (= *Lejeunea vagans* Spruce, Jour. Linn. Soc. Bot. **30**: 339. 1894).

distant, orbicular, 0.15 mm. long, bifid about two thirds with erect triangular and acute lobes separated by a narrow sinus, margin entire or repand, rarely indistinctly crenulate from projecting cells: inflorescence autoicous: ♀ inflorescence borne on a very short branch without innovation; bracts widely spreading, the lobe ovate, 0.7 mm. long, 0.45 mm. wide, apex broad but usually apiculate, margin as in the leaves, lobule oblong to lanceolate, 0.35 mm. long, 0.12 mm. wide, rounded to acute at the apex, margin entire; bracteole free, ovate-orbicular, 0.5 mm. long, 0.4 mm. wide, bifid about one third with erect, acute or obtuse, triangular lobes and narrow sinus, margin slightly and irregularly denticulate from projecting cells; perianth triangular in outline with nearly straight sides, 0.85 mm. long, 0.7 mm. wide in broadest part, postical keel broad and rounded, apex obcordate with a short but distinct beak, lateral keels extended upward as rounded auricles and bearing above the middle two narrow and interrupted, denticulate or shortly spinulose wings, surface of perianth slightly roughened from projecting cells: ♂ inflorescence usually occupying a short branch but sometimes terminal on a longer branch; bracts in two to four pairs: mature sporophyte not seen (PLATE 11, FIGURES 1–17).

On shaded rocks. El Yunque, *Evans* (*129*, *169*). *No. 169* may be designated as the type.

The species described above agrees in many respects with Spruce's *Lejeunea denticulata*, as represented by the specimens distributed in the *Hepaticae Spruceanae*. It differs very considerably, therefore, from the *Lejeunea denticulata* of Stephani and Gottsche. Stephani (*in litt.*) refers *P. aequitexta* with some question to a manuscript species of Gottsche and calls attention to the slight variation in the size of the leaf-cells. As however this determination is not altogether certain, and as Gottsche's species has never been published even as a *nomen nudum*, it seems advisable to give the Puerto Rico plant a different name.

Spruce compared his *Lejeunea denticulata* with *L. decora* Tayl.,* originally collected on the island of Dominica, but threw doubt on the validity of the latter species. Later, however, he referred to it provisionally a plant collected by Elliott on St. Vincent.† According to Bescherelle the species has also been found on Guadeloupe by L'Herminier.‡ The type-specimen of *L. decora*

* Lond. Jour. Bot. **5**: 393. 1846.

† Jour. Linn. Soc. Bot. **30**: 338. 1894.

‡ Jour. de Bot. **7**: 177. 1893.

in the Taylor herbarium is exceedingly fragmentary but is sufficient to show that the species is distinct not only from Spruce's *L. denticulata* but also from *P. aequitexta*. It is characterized by its narrower and more gradually acute leaves, by its smaller underleaves which are relatively broader and less deeply bifid, by its narrower bracteole with entire or subentire margin, and by its perianth which has a very rudimentary beak and sharply laciniate wings. Its inflorescence is apparently dioicous. Judging from the type-specimen, *P. bicristata* Steph., * also collected by L'Herminier on Guadeloupe, is a synonym of *L. decora*, although this could hardly be determined from Taylor's very incomplete description.

Prionolejeunea aemula (Gottsche)

Lejeunea aemula Gottsche; G. L. & N. Syn. Hep. 338. 1845.

Lejeunea (*Priono-Lejeunea*) *aemula* Steph. Hedwigia, **29**: 69. 1890.

Lejeunea (*Prionolejeunea*) *vulcanica* Spruce, Jour. Linn. Soc. Bot. **30**: 337. *pl. 21. f. 1–3.* 1894.

Prionolejeunea vulcanica Schiffn. Bot. Jahrb. **23**: 590. 1897.

Dull pale green, becoming brownish upon drying, loosely tufted and often mixed with other hepatics: stems 0.09 mm. in diameter, prostrate and loosely adherent to the substratum, sparingly branched, the branches obliquely to widely spreading: leaves slightly imbricated (or sometimes distant on small-leaved branches), the lobe obliquely spreading, convex, scarcely falcate, 0.5 mm. long, 0.45 mm. wide, outer part ovate to orbicular, very abruptly dilated from a narrow and contracted basal region, antical margin strongly incurved near the base then strongly outwardly curved to apex, postical margin also strongly outwardly curved, forming an angle of 90° or less with the keel, apex broad but usually abruptly apiculate or short-acuminate, whole margin (except close to the antical base) densely and regularly denticulate from projecting cells; lobule inflated throughout, ovoid, 0.17 mm. long, 0.12 mm. wide, keel strongly arched, free margin curved, involute to apex but usually appressed to lobe, sinus broad and lunulate, apical tooth slightly curved; cells of lobe slightly convex, averaging 20 μ at the margin, 24 μ in the middle and 35 × 24 μ at the base, rather thin-walled, trigones and intermediate thickenings small but distinct: underleaves distant, orbicular, 0.2 mm. long, bifid about one half (to within two or three cells of the radicelliferous region) with erect triangular lobes, acute or obtuse or even

* Hedwigia, **35**: 118. 1896.

rounded at the apex, and a broad obtuse to lunulate sinus, margin subentire to crenulate from projecting cells, sometimes angular-unidentate on the sides: inflorescence autoicous: ♀ inflorescence borne on a very short branch without innovation, the leaves of the branch being usually reduced to a rudimentary leaf and underleaf but sometimes with a pair of normal leaves interpolated between the rudimentary leaf and the involucre; bracts widely spreading, the lobe obovate, 0.6 mm. long, 0.35 mm. wide, rounded to subacute at the apex, margin as in the leaves, lobule oblong, usually blunt, 0.35 mm. long, 0.12 mm. wide, margin subentire; bracteole free, ovate, 0.6 mm. long, 0.35 mm. wide, bifid about one half with acute lobes and a narrow sinus, margin as in the leaves but with rather more irregular teeth; perianth triangular in outline with nearly straight sides, 0.75 mm. long, 0.6 mm. wide in broadest part, postical keel broad and rounded, apex truncate, slightly indented in the middle, beak obsolete, lateral keels extended upward as rounded auricles and bearing above the middle two interrupted and very narrow, denticulate wings, each tooth one or two cells long, surface of perianth smooth or nearly so: ♂ inflorescence occupying a short branch; bracts in one to three pairs: mature sporophyte not seen (PLATE 11, FIGURES 18–28).

On a rotten log, *Evans* (*103 p. p.*). Originally collected by *Breutel* on St. Kitts, the type-locality, and recently found by *Britton* and *Cowell* on the same island. Also known from Dominica, *Elliott*.

The most striking character of *P. aemula* is the very abrupt dilation of the lobe just beyond the lobule; this is sometimes so marked that a distinct passage-way is left between the base of the lobe and the axis (FIGURE 19), giving the plant a most peculiar appearance. The marginal teeth or crenulations of the underleaves, although not constant, should also be especially noted. In the female inflorescence the denticulate bracteole and the slightly retuse perianth with obsolete beak are perhaps the most important features, when comparing *P. aemula* with its immediate allies. Certain of these peculiarities are not clearly shown in the figures published by Spruce.

According to Gottsche, the leaves of *P. aemula* are coarsely serrate and the lateral keels of the perianth are sometimes minutely and sparingly ciliate and sometimes nearly entire. In his description of *L. vulcanica*, Spruce calls attention to its close relationship with Gottsche's species but separates it because its leaves are minutely crenulate or serrulate and its perianth is subdenticu-

late. A careful comparison of the types of these two species shows, however, that they are not distinct and that the differential characters upon which Spruce relied are not apparent. In all probability he based his decision on Gottsche's description alone and had no opportunity of consulting the type-specimens. The leaf-cells of *L. vulcanica* are described as being destitute of trigones, but these are represented in the published figure and the type-specimen shows them almost everywhere. They are smaller than is usual in the species but vary markedly in size even on the same plant and are sometimes fully as large as in the typical material of the species.

Among the Puerto Rico species of *Prionolejeunea*, the closest ally of *P. aemula* is perhaps *P. aequitexta*, the two species agreeing in their general appearance, in their autoicous inflorescence and in their lack of subfloral innovations. *P. aemula*, however, is clearly distinct in the very abrupt dilation of its leaf-lobes, in its more sharply denticulate leaves, bracts and bracteoles, in its smaller underleaves with variable margins, and in its nearly beakless perianth. Another close ally is *Lejeunea serrulata* Mont., of Cuba.* This species is still known from the original specimens only, which are destitute of perianths. It is dioicous, and the female branch, although usually simple, sometimes innovates. The species is further remarkable for its distinctly crenulate underleaves, the teeth being found along the inside of the sinus as well as elsewhere. The leaf-margins of *L. serrulata* are very much as in *P. aequitexta*.

Prionolejeunea Helleri sp. nov.

Dull yellowish green, becoming brownish upon drying, loosely and intricately caespitose: stems 0.09 mm. in diameter, prostrate and loosely adherent to the substratum, sparingly branched, the branches obliquely to widely spreading: leaves contiguous or slightly imbricated, the lobe obliquely spreading, plane or somewhat convex, more or less falcate, 0.4 mm. long, 0.35 mm. wide, outer part broadly ovate to orbicular, dilated from a narrow basal region, antical margin straight or slightly incurved near base, then strongly outwardly curved to apex, postical margin also more or less outwardly curved, forming a rather blunt angle, 90° or more, with the keel in well-developed leaves, apex broad but usually abruptly apiculate, whole margin (except close to the antical base)

* Ramon de la Sagra, Hist. phys. pol. et natur. de Cuba, **9**: 479. *pl. 18. f. 3.* 1845.

sharply and irregularly denticulate or serrulate from projecting cells, the teeth along the postical margin a little blunter than elsewhere; lobule inflated throughout, ovoid, 0.15 mm. long, 0.1 mm. wide, keel strongly arched, free margin straight or nearly so, involute to beyond apex but usually appressed to lobe, sinus lunulate, apical tooth rather sharp and slightly curved; cells of lobe slightly convex, averaging 15 μ at the margin, 21 μ in the middle and 25 × 21 μ at the base, rather thin-walled, with small but distinct trigones and occasional intermediate thickenings: underleaves distant, broadly orbicular, 0.14 mm. long, 0.15 mm. wide, bifid about two thirds (to within a single cell of the radicelliferous region) with triangular acute lobes separated by a broad acute to lunulate sinus, margin usually with a distinct angular tooth on each side, otherwise entire: inflorescence autoicous: ♀ inflorescence borne on a very short branch without innovation; bracts widely spreading, the lobe falcate-obovate, 0.5 mm. long, 0.35 mm. wide, apex apiculate or acute, margin as in the leaves but with rather more conspicuous and irregular teeth, lobule oblong to lanceolate, 0.18 mm. long. 0.05 mm. wide, apex blunt to sharp, margin entire; bracteole free, ovate, 0.35 mm. long, 0.2 mm. wide, bifid one third to one half with erect or connivent, acute to acuminate lobes and a narrow sinus, margin usually entire, sometimes with a single tooth on one or both sides; perianth triangular in outline with straight or somewhat incurved sides, 0.75 mm. long, 0.65 mm. wide, postical keel low and broad, apex deeply obcordate and with a short beak, lateral keels extended upward as rounded auricles, each developing in the upper part two distinct and deeply laciniate wings, the laciniae one to five cells long and one to four cells wide at the base, surface of perianth smooth or slightly roughened from projecting cells: ♂ inflorescence occupying a short branch; bracts in one to six pairs, strongly inflated and shortly bifid, the lobe acute and slightly denticulate, the lobule blunt and entire, keel strongly arched, narrowly winged in the outer part, the wing composed of a single row of crenulate cells; bracteoles in lower part of spike, similar to the underleaves but smaller: mature sporophyte not seen (PLATE 12, FIGURES 1–13).

On roots of tree ferns. North slope of the Luquillo Mountains, *Heller* (*4633*). El Yunque, *Evans* (*148*). *No. 148* may be designated the type.

In the perianth of *P. Helleri* the sides are sometimes nearly straight instead of being strongly incurved as in the figured specimen; the conspicuous wings, however, seem to be a constant feature although the laciniae vary considerably in length. Per-

haps the most striking peculiarities of the species, aside from these wings and the short but distinct beak of the perianth, are the small and deeply bifid underleaves, which are usually unidentate on the sides, and the narrow bracteoles, which are destitute of marginal denticulations.

Among the other Puerto Rico species of *Prionolejeunea*, *P. innovata* and *P. aemula* bear some resemblance to the species just described. In *P. innovata*, however, the underleaves are larger and less deeply bifid, the female branch bears a subfloral innovation, the bracteole is broader and is crenulate or denticulate on the margin, the perianth is less deeply emarginate and the apical beak is obsolete. In *P. aemula* the lobes of the leaves are much more abruptly dilated, the margins are more regularly denticulate, the underleaves have blunter divisions and are usually crenulate on their margins, the bracteole is distinctly denticulate, the beak of the perianth is obsolete, and the wings are less conspicuously toothed.

Prionolejeunea exauriculata sp. nov.

Dull yellowish green, becoming brownish upon drying, growing in depressed and intricate mats: stems 0.09 mm. in diameter, prostrate, sparingly branched, the branches widely spreading: leaves contiguous or loosely imbricated, the lobe obliquely spreading, plane or slightly convex, sometimes reflexed at the apex, somewhat falcate, 0.5 mm. long, 0.4 mm. wide, outer part varying from ovate or obovate to orbicular, dilated from a narrow basal region, antical margin slightly incurved near base, then strongly outwardly curved to apex, postical margin also strongly outwardly curved, forming a sharp angle, 90° or less, with the keel on well-developed leaves, apex broad, usually abruptly apiculate, more rarely acute, obtuse or even rounded, whole margin (except close to antical base) minutely and irregularly crenulate or bluntly denticulate from projecting cells; lobule inflated throughout, ovoid, 0.17 mm. long, 0.1 mm. wide, keel strongly arched, free margin involute to beyond apex, sinus lunulate, apical tooth curved and rather sharp; cells of lobe slightly convex, averaging 16 μ at the margin, 20 μ in the middle and 32 × 20 μ at the base, walls rather thin, with small but distinct trigones and occasional intermediate thickenings: underleaves distant, broadly orbicular, 0.18 mm. long, 0.2 mm. wide, bifid about one half (to within two or three cells of the apical region), with erect, triangular, acute lobes separated by a broad, acute to rounded sinus, margin entire or vaguely crenulate from projecting cells, rarely unidentate on the

sides: inflorescence dioicous: ♀ inflorescence borne on a very short branch without innovation; bracts obliquely spreading, the lobe obovate, 0.6 mm. long, 0.45 mm. wide, rounded or apiculate, margin irregularly denticulate, lobule oblong to lanceolate, 0.35 mm. long, 0.1 mm. wide, blunt or pointed, margin entire or slightly crenulate; bracteole free, ovate to oblong, 0.5 mm. long, 0.3 mm. wide, bifid about one half with narrowly triangular, erect and acute lobes separated by a narrow sinus, margin irregularly crenulate as in the leaves, especially in the upper part, rarely unidentate on the sides; perianth oblong in outline from a somewhat narrowed base, 0.9 mm. long, 0.4 mm. wide, somewhat flattened but with rounded lateral keels, apex truncate or rounded, abruptly contracted into a very short beak, surface roughened from convex or rarely conical cells especially along the lateral keels: ♂ inflorescence and mature sporophyte unknown (PLATE 12, FIGURES 14–28).

On shaded rocks. El Yunque, *Evans* (*179*).

The generic position of this distinct little species is not altogether certain. Its leaves and underleaves are clearly those of a *Prionolejeunea*, and in sterile condition there is little to distinguish it from such species as *P. Helleri*, *L. decora* and *L. macrocardia*. In its abbreviated female branch it also shows a clear relationship with this same genus. Its aberrant character is shown in its perianth, which, although somewhat flattened, entirely lacks the conspicuous auricles found in all other known species. It hardly seems advisable, however, to make it the type of a distinct genus on this account alone, and there is certainly no other established genus with which it shows so many points in common as with *Prionolejeunea*.

Aside from its peculiar perianth, *P. exauriculata* differs from the other species found in Puerto Rico in its dioicous inflorescence and in the less prominent crenulations of its leaves and bracts. The lobules, leaf-cells and underleaves offer few additional points of difference. From *P. Helleri* and from *L. decora* it may be further distinguished by its blunter or even rounded leaves, and from *L. macrocardia* by its dioicous inflorescence and by its lack of a subfloral innovation.

In the preparation of this paper the writer has received assistance from Mr. M. B. Slater, Professor W. G. Farlow, Dr. G. Lindau and Herr F. Stephani. In fact, the discussion of the difficult genus *Prionolejeunea* would hardly have been possible had it not been for their kind coöperation.

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Explanation of plates 8-12

As in the previous papers of this series, the figures were drawn by the writer and prepared for publication by Miss Hyatt.

PLATE 8

Odontolejeunea lunulata (Web.) Schiffn. 1. Branch with perianth, postical view, × 19. 2. Part of stem with two underleaves dissected away, postical view, × 14. 3. Cells from middle of lobe, × 265. 4. Cells from antical margin of lobe, × 190. 5. Teeth from inner part of the free margin of lobule, × 190. 6. Tooth from outer part of the free margin, showing also the hyaline papilla, × 190. 7. Teeth from apex of underleaf, × 190. 8, 9. Bracts, × 19. 10. Bracteole, × 19. 11. Tooth from wing of perianth, × 190. 12. Branch with attached propagulum, × 19. 13. Germinating propagulum, × 19. 14. A part of the second underleaf of a germinating propagulum, × 190. 15. Longitudinal section through same, × 190. The figures were all drawn from Jamaican specimens collected by the writer (*319*).

Cyclolejeunea Chitonia (Tayl.) Evans. 16. Branch with two perianths, postical view, × 195. 17. Part of stem, postical view, × 219. 18. Leaf, antical view, × 190. 19. Cells from middle of lobe, × 265. 20. Cells from antical margin of lobe, × 190. 21. Same from another leaf, × 190. 22. Apex of lobule, × 190. 23. Bracts and bracteole, × 19. The figures were all drawn from specimens collected by the writer (*75*, *82*).

PLATE 9

Cyclolejeunea convexistipa (Lehm. & Lindenb.) Evans. 1. Part of stem with two female branches, postical view, × 35. 2. Branch with perianth, postical view, × 35. 3. Two leaves, antical view, × 35. 4. Modified branch, postical view, × 35. 5. Cells from middle of lobe, × 310. 6. Cells from antical margin of lobe, × 220. 7, 8. Apices of normal leaves, × 220. 9. Apex of leaf from modified branch, × 220. 10. Apex of lobule, × 220. 11, 12. Bracts, × 35. 13. Bracteole, × 35. 14. Apical region of mature gemma, showing apical cell, × 220. 15. Germinating gemma, showing the two basal cells, the rhizoids and the young leafy shoot, × 50. 16. Rhizoids of germinating gemma, × 220. The figures were all drawn from specimens collected by the writer (*19*, *162*).

Cyclolejeunea accedens (Gottsche) Evans. 17. Apex of lobule, × 220. 18–20. Developing gemmae, × 220: in fig. 18 the mother-cell has just divided by an oblique wall; in fig. 19 the apical cell is well established and the two basal cells can be clearly distinguished; in fig. 20 the cell-division is practically ended but the apical cell is still distinct. These three figures show the antical aspect of the attached gemmae, and in fig. 20 the two young marginal rhizoids can be indistinctly seen through the cells. 21. Adult gemma seen from below, × 220: the apical cell is no longer to be distinguished, the basal cells show the region of attachment to the stalk-cell and the rhizoids have attained their full development. 22. Germinating gemma, antical view, showing a gemmothallium growing out from one of the basal cells and producing a young leafy shoot at its apical end, × 50. 23. Germinating gemma, postical view, showing a gemmothallium with a leafy shoot growing out from the apical region and a second gemmothallium without a leafy shoot growing out from one of the basal cells, × 50. The figures were all drawn from specimens collected by the writer (*20 p. p.*).

PLATE 10

Cyclolejeunea angulistipa (Steph.) Evans. 1. Part of plant with perianth, postical view, × 35. 2. Part of stem, postical view, × 35. 3. Cells from middle of lobe, × 310. 4. Apex of lobe, × 220. 5. Apex of lobule, × 220. 6. Underleaf, × 220. 7. Bract, × 35. 8. Bracteole, × 35. 9. Leaves with gemmae, antical view, × 25. 10–14. Developing gemmae, × 220: in fig. 10 the mother-cell has not yet been cut off from the stalk-cell; in fig. 11 this division has taken place and the mother-cell has divided by a longitudinal wall; in fig. 12 the two basal cells and the two apical cells may be seen; in figs. 13 and 14 a series of segments have been cut off by the apical cells. 15. Part of adult gemma, showing the still active apical cell, the basal depression where the stalk-cell is attached and three marginal rhizoids, × 220. 16. Germinating gemma with a young leafy shoot growing from one of its apical regions, × 50. 17. Proliferating gemma, × 35. The figures were all drawn from specimens collected by A. A. Heller (*4716, 4738*).

Prionolejeunea innovata Evans. 18. Branch with perianth and antheridial spike, postical view, × 35. 19. Part of stem, postical view, × 35. 20. Leaf, antical view, × 35. 21. Cells from middle of lobe, × 310. 22. Cells from antical margin of lobe, × 220. 23. Apex of lobe, × 220. 24. Apex of lobule, × 220. 25. Part of underleaf, × 220. 26. Bract, × 50. 27. Bracteole, × 50. The figures were all drawn from the type-specimens.

PLATE 11

Prionolejeunea aequitexta Evans. 1. Part of plant with perianth, postical view. × 35. 2. Leaf, antical view, × 35. 3. Cells from middle of lobe, × 310. 4, Cells from antical margin of lobe, × 220. 5–7. Apices of lobes, × 220. 8. Apex of lobule, × 220. 9. Basal part of underleaf, × 220. 10–12. Apices of underleaf-divisions, × 220. 13, 14. Bracts, × 35. 15, 16. Bracteoles, × 35. 17. Cross-section of perianth, × 35. The figures were all drawn from the type-specimens.

Prionolejeunea aemula (Gottsche) Evans. 18. Part of plant with perianth and unfertilized female inflorescence, postical view, × 35. 19. Two leaves, antical view, × 35. 20. Cells from middle of lobe, × 310. 21. Cells from antical margin of lobe, × 220. 22. Apex of lobe, × 220. 23. Apex of lobule, × 220. 24. Part of underleaf, × 220. 25. Lateral tooth of underleaf, × 220. 26, 27. Bracts, × 35. 28. Bracteole, × 35. The figures were all drawn from specimens collected by the writer (*103 p. p.*).

PLATE 12

Prionolejeunea Helleri Evans. 1. Part of plant with perianth and male inflorescence, postical view, × 35. 2. Part of stem, postical view, × 35. 3. Leaf, antical view, × 35. 4. Cells from middle of lobe, × 310. 5. Cells from antical margin of lobe, × 220. 6. Apex of lobe, × 220. 7. Apex of lobule, × 220. 8. Underleaf, × 220. 9–11. Bracts, × 50. 12, 13. Bracteoles, × 50. The figures were all drawn from the type-specimens.

Prionolejeunea exauriculata Evans. 14. Part of plant with perianth, postical view, × 35. 15. Leaf, antieal view, × 35. 16. Cells from middle of lobe, × 310. 17. Cells from antical margin of lobe, × 220. 18, 19. Apices of lobes, × 220. 20. Apex of lobule, × 220. 21. Part of underleaf, × 220. 22. Apex of underleaf-division, × 220. 23–25. Bracts, × 35. 26, 27. Bracteoles, × 35. 28. Cross-section of perianth, × 35. The figures were all drawn from the type-specimens.

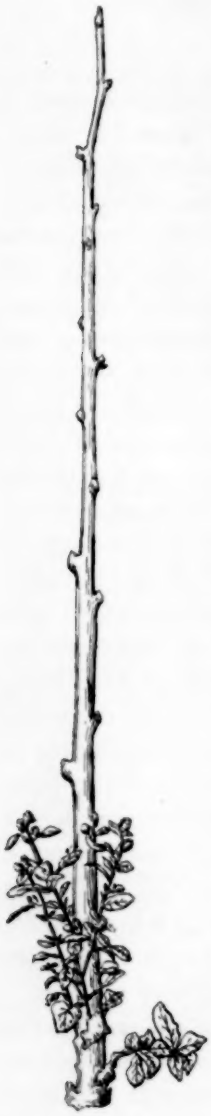
Polarity and regeneration in plants

T. H. Morgan

The earlier and greater development of the buds that stand at the distal end of a piece of a willow than of those that stand nearer to the base of the piece bears a certain general resemblance to the phenomenon of polarity in animals, and has led, in fact, to the use of the same word for both processes. This comparison needs, I think, to be more critically examined. During the past summer I have kept pieces of several plants, from which the leaves were removed, in a moist chamber with the lower end of the pieces in water, and have watched the development of the buds. In most cases, as in the willow, the more distal, *though not necessarily the most distal*, buds are the first to develop, and it could be easily seen that those that unfolded first were, as a rule, the largest and most advanced buds present on the piece when it was removed from the plant. In other words, the relative strength of the buds determines which develop first, and it seems most plausible that in consequence of this development the other buds might be kept from unfolding because those that got the start used up all the available food substances that were present, or were being manufactured in the piece. It appears, therefore, that the result is not so much the outcome of the polarity of the piece, acting at the time of regeneration, as of preexisting conditions in the piece at the time of its removal from the plant. These determine which buds shall be the first to unfold. Whether or not this difference in the condition of the buds of the original piece has itself been regulated by polar relations in the growing point is a question for further consideration, but in any case it is one that does not involve the immediate question of the regeneration of the isolated piece.

In one of the plants that I examined, the proximal and not the distal buds of the piece were the first to develop. It is this case that I wish more especially to discuss in connection with the problem of polarity in plants. The plant was the common burdock, *Arctium Lappa* (*Lappa officinalis*). The leaves and the lateral branches were cut off from half a dozen vigorous plants, and the

denuded stalk was left standing in place in connection with its original roots. In the course of about ten days new buds began to grow out near the base of the stalk. They unfolded rapidly and at the end of about two weeks had reached the condition shown in the figure. The new shoots arose in or near the angles between the main stem and the lateral branches (which had been cut off). These branches stand in the axils of the lower leaves. No shoots at all appeared in the upper regions of the stem, although the latter remained green and in good condition. It may appear that the results in this case are connected with the attachment of the stem to the old roots. The fact that large branches arise near the base of the main stem may be interpreted to mean that these parts receive a large share of the substances that come up from the roots. In order to see if this suggestion had any value I cut off other stems from their roots, stripped them of their leaves and branches, and placed the lower ends in dishes of water. In these cases also the lower buds alone unfolded and none appeared in the upper parts of the stem.



To determine whether the result is due to the better development of the buds at the base rather than due to the movement towards the base of food or of so-called formative substances, I cut a few of the stems into three pieces. In those in which any development took place this occurred in the basal pieces, and in one case in the lower part of the second piece as well, but no buds developed in the distal pieces, although to all appearances these remained in good condition. Whether these distal pieces would after a much longer time (I kept them nearly three weeks) have developed buds, I do not know.

This last experiment, while not satisfactory in all respects, yet suffices to show that the development of the basal buds in the long pieces is not due to the polarity localizing, as it were, the development at the base, nor to the flow of substances downward, but is due to the stronger buds being present in the basal region.

These results recall the cases of *Lilium candidum* and *Lachenalia luteola*. These plants do not set seed, but produce bulblets at the base. This formation of basal bulblets is attributed by Goebel to the flow of food substances in the plants towards the base which causes the bulblets to develop in this region, and at the same time deprives the seeds of the necessary material for their development. The explanation appears to me to be exactly the reverse. The buds that give rise to the bulblets in these plants are so vigorous that they utilize all of the food substances that are present, and thus deprive the seeds of food material that they might possibly make use of if the bulbs did not develop. It is not, I think, the flow of food substances downwards that causes the bulblets at the base to develop, but the vigorous bulblets in this region draw into themselves so much of the available food substances that not enough is left for the seeds.

It might be claimed in the case of the burdock, that when the stalk, deprived of its leaves, is left attached to the old roots, material from the roots rising up into the stem will affect the basal buds first; or it might be claimed that since there are large fibro-vascular bundles that go to the basal nodes these bring to this region materials from the roots that cause the buds to develop, but that this is not the real explanation was shown above by the experiment of removing the stem from the roots. The result appears to be due rather to the more vigorous condition of the basal buds. Whether, as I have said, this condition of the plant is itself to be thought of as ultimately the outcome of its polarity, is a question that I do not think we can profitably discuss as yet. If it is, then the polarity in the growing point has already acted and determined the relative development of the buds in the different regions. When the piece containing these buds is removed, their further development is first determined by the stage that they are already in, or by their greater vigor, which may, in most cases, mean the same thing. In the second place certain buds having gotten a start use up all or most of the available food materials and thus check the further development of the other buds.

In the light of these facts and conclusions certain of the statements that I made in my book on "Regeneration" in regard to the cause of the development of the apical buds in a piece of the willow must be recast. The development of the apical buds of the willow, and of other similar plants, and of the basal buds in the burdock appear both to be due, not to a dynamic relation (polarity) between the two ends of the piece, but to a static condition already existing in the piece before its removal, namely, the relative state of development of its buds.

From this point of view Sachs' theory of formative stuffs plays no directive part in the regeneration of pieces of the plants. The presence of food stuffs enters into the problem only in so far as certain parts are supposed to be able to draw on that which is present, while other parts (the less developed buds) are not so able to make use of the common supply. The flow of these food stuffs through the plant appears from this point of view not to be due to the stuffs tending to flow of themselves in certain directions, or as the result of the action of some outside agent, as gravity, but their flow may be simply a question of diffusion from those places where they exist in larger amounts to other places where there is not so much of the substance present. If the more vigorous and somewhat older parts can make use of this material more rapidly than can the less well-developed parts, there will be a steady flow of soluble food substances towards the growing parts, because in these regions the material is being more rapidly used up, and hence the region is relatively poorer in these materials. The flow is then a purely physical problem. This assumption is, of course, not different from that usually employed by botanists to account for the flow of soluble substances from one part of a plant to other parts.

It appears, therefore, that polarity in the plant is not the cause of the flow of substances through the plant, as Goebel seems to imply in certain parts of a recent article,* nor does polarity appear to regulate the development of certain buds and hold others in check.† Possibly some such factor may determine in the growing regions of the plant the relative rate of development of certain buds, but even this is not certain and remains to be further examined.

BRYN MAWR COLLEGE.

* Goebel. Bull. Torrey Club, **30**: 197–205. 1903. Also Biolog. Centralbl. **22**: 385–397, 417–438, 481–505. 1902.

† Morgan. Bull. Torrey Club, **30**: 206–213. 1903.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1904)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

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